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EDITORIAL NOTE

On the appearance of the second number of this periodical the Editorial Committee wish to express their gratitude to all who subscribed to the first issue and to assure them that their support has been most encouraging. Supplies of the first issue, apart from a small number of copies placed in reserve, are almost exhausted. It is equally gratifying to record that, while the bulk of subscribers are naturally drawn from the East Midlands, those from other parts of the country and abroad are substantially more numerous than was anticipated.

That the East Midlands, with its particular physical divisions, its abundant economic resources, its continually (and in places rapidly) evolving landscape patterns, is an area fruitful for geographical investigation cannot be doubted. It is a part of England in which to a marked degree the rich legacy of history is being augmented by developments which denote an increasing recognition of its potentialities in relation to modern needs. It will continue to be the primary object of this publication to interpret the character of the East Midlands from the geographical point of view, to record the developments and changes that occur within its limits and of course where necessary to relate these to the wider compass of the country as a whole.

Clearly it will not be possible, nor even desirable, to devote equal attention to all parts of the area in each issue but it is hoped that over a period a fair balance in this respect will be attained.

GEOGRAPHICAL ASPECTS OF THE DEVELOPMENT OF BOSTON (LINCS.) BETWEEN 1700 AND 1900 A.D.

G. JOAN FULLER

Few English ports have suffered greater vicissitudes of fortune than Boston. From a comparatively late and obscure beginning—it was not mentioned in Domesday—it grew to outstanding prosperity by the year 1205 when its commerce ranked second to that of London. During the next two centuries it continued to be the chief wool port and a centre for imports from the Baltic and the Low Countries. Then came decline, partly owing to economic causes, notably to changes in the wool trade, and partly to silting in the Witham estuary. The seventeenth century saw little improvement. Indeed the port was in still greater distress because of silting(1). On the other hand, farming in the surrounding area was moderately flourishing and Boston's livelihood gradually became more dependent on its markets. From this point, a low water mark in some respects in the fortunes of the town, we may follow in more detail the development of Boston during the eighteenth and nineteenth centuries.

At the beginning of the eighteenth century ships were small and transport was both easier and cheaper by water than by land. One result of this was that commerce was shared between a far larger number of ports than today. Lincolnshire and Norfolk were served by fourteen official ports between Grimsby and Yarmouth. Of these the four principal ports of the Wash had peculiar advantages, each being situated on the estuary of a relatively large river which linked the port with a wide hinterland. Though King's Lynn on the Ouse was the outlet for the longest of these river navigations, the Witham was navigable from Boston to Lincoln and beyond that point vessels could follow the Fossdyke to the Trent. There were, however, difficulties affecting both sea and river approaches to Boston at this time. Despite the use of beacons, the shifting sandbanks and channels of the Wash were a constant danger, "two hundred sails having not long since perished at once for want of knowledge of our channels"(2). Above Boston the Witham navigation was deteriorating, reducing year by year the traffic between Boston and Lincoln. In addition the river banks were in disrepair, allowing tide water to break into the fens.

Roads, in spite of their frequent disabilities, were of some importance to Boston. Fig. 1 shows that Lincolnshire had the advantage of lying athwart two main routes between London and the north. Boston, separated from these by the fen, was somewhat isolated but was sufficiently important to be connected with London by a highway branching from Ermine Street and running through Peterborough. Another road crossed Holland Fen from Boston to Sleaford and Lincoln. Thus Boston itself had routes to London and the north. Knowledge of the condition of the roads in 1700, however, is more difficult to find than

(1) See G. M. Hipkin, Social and Economic Conditions in the Holland Division of Lincs. from 1640-60, *Reports and papers of Assoc. Arch. Soc.*, Vol. 40, 1931.

(2) Christopher Merret, An Account of Several Observables in Lincolnshire not taken notice of in Camden or any other Author, *Phil. Trans.* 1694-7, Vols. 18, 19, p. 352.

their direction. At this time there were no turnpike activities in Lincolnshire and the parish surveyors, in an area conspicuous both for its ill-drained terrain and its lack of roadstone, faced particular difficulties. Although Ogilby's *Travellers' Guide* (1) described the London-Boston road as "generally good, the fenny parts being raised with causeways", a local man, writing of another causeway (from Donington to Bridge End), reported that it was "under water after great rains"(2). It is probable therefore that the Lincolnshire fens still formed a barrier to land transport.

Fig. 1

Early Eighteenth Century Boston.

Detailed information about the town of Boston at the beginning of the eighteenth century is not easy to find. There is, for example, no good contemporary plan. Nevertheless Hall's Map published in 1741(3), is probably, in essentials, a picture of the town forty years earlier. (See Fig. 2). Boston like its rival, King's Lynn, lay nearer to the sea than Spalding and Wisbech, and had the advantage of deeper water than the two latter ports. It was situated six miles from the Wash, at a point where the Witham cut through the higher silt lands between the fen and the marshlands. In so low an area every foot of elevation was of

(1) Published in 1699.
(2) C. Merret, op. cit., 351.
(3) Robert Hall, Map of the Borough and Port of Boston, 1741.

value and it was a decisive advantage in the siting of Boston that its nucleus round St. Botolph's church developed where there was a slight rise, a little hill twenty feet above sea level opposite a corresponding patch of "high ground" on the other bank of the Witham. Here the

1. St. Botolph's Church
2 Custom House
3 Guildhall
4 Grammar School
5 Mart Yard
6 Packhouse Key
7 Doughty Key
8 Wide Bargate
9 The Pumps

A Butter Cross
B Meal Cross
C The Butchery
D Fish Stalls
E Bargate Pound
F Sheep Pens
G Horsepond and Pound

Fig. 2 (Based on Robert Hall's map).

river narrowed to about eighty feet. Thus the site offered relative safety from floods and the first good bridge-point upstream. The narrowness of the Witham at Boston compared with the greater width of the Ouse at King's Lynn appears to have had an important influence on the form of the settlement, the ease of bridging at Boston allowing the town to

develop on both banks whereas at Lynn the wide estuary precluded bridge building and the town grew up on the right bank only. Hall's map shows that Boston in the early eighteenth century extended linear fashion along both banks of the Witham. Building in west Boston followed the High Street, the water front being built up except at Doughty Key. West Boston appears to have been less important at this time than the eastern part for the latter contained the market-place dominated by the great wool church, the Custom House, the Guildhall, and the Grammar School whose Mart Yard was the site of the once famous fair. As in west Boston a main road ran parallel with the river, separated from it by buildings except in South Square where, close to the Custom House, was Packhouse Key. For the most part, east Boston lay within the confines of the Barditch which, like the walls of other mediaeval towns, limited expansion. Nevertheless the town had grown beyond Barditch in the north-east where the road from the market place emerged from Bargate. Here buildings lined a triangular area called Wide Bargate where the greater space was convenient for stock sales. Thus market development had modified the linear pattern of Boston, encouraging growth inland away from the river. Physically also this north-eastern extension is of interest for it followed a tongue of "high" ground projecting from the market-place. In 1700 therefore the morphology of Boston reflected both the physical conditions of the site and its two chief functions as port and market town. It is a further task to examine these functions in detail.

At the beginning of the eighteenth century the harbour consisted of the river between Boston Bridge and the Black Sluice, the two principal quays lying a little below the former. Since the Grand Sluice was not yet built, there was little check to the inrush of the tides which flowed upstream for five miles above the town, providing deep water and a tidal scour. The tides were both an advantage and a danger. The port surveyor wrote in 1696, "of late there are eagres (i.e. tidal bores), sometimes endangering shipping . . . . which much destroys its (Boston's) banks and keys, tho' fortified with great piles and jetties"(1).

Contemporary writers suggest that the port appeared to be more flourishing than in the mid-seventeenth century. In addition to their observations there are the Port Books which provide material for a systematic evaluation. It must, however, be noted that the Port Books are not entirely satisfactory. The records are incomplete and, because of smuggling, the quantities of goods recorded are probably unreliable. It is therefore impossible to make a full analysis of Boston's trade. On the other hand, from a list of the origins and destinations of ships using the port, and from a survey of their cargoes, a general picture emerges. In the first place foreign trade was small. Between 1700 and 1720 the numbers of incoming vessels fluctuated between a minimum of five in 1710 and a maximum of twenty-seven in 1714. Most of these ships came from Norwegian ports on the Oslo Fjord and there were a few also from Sweden. Their cargoes were largely made up of naval stores and there were one or two records of Swedish iron. A few ships brought goods from Holland, especially from Rotterdam. These cargoes were varied and included manufactures such as earthenware, tiles and linen. Other items were "Spaw water" and Rhenish wine. During certain years one or two vessels brought wine from Spain or Portugal and also raisins, oranges, lemons and cork.

(1) C. Merret, op. cit., 347.

Exports were fewer than imports. The greatest number of shipments in a year was eleven, the average one to five, and in several years there were none. Although shipments were few, the cargoes showed variety. Agricultural exports to Norway and Holland included wheat, barley, oats, rye, malt and rape seed. Certain manufactures were sent to Norway and Portugal including kersies and broadcloths. There was an occasional export of hides to Norway and Portugal and some coal was re-shipped to Holland and Portugal.

In the early eighteenth century Boston's coastwise trade was far more important than its foreign trade. Although the records are incomplete, it is certain that the largest number of incoming vessels brought coal from Northumberland and Durham. In 1710 for example, 166 ships landed coal at Boston, 155 of them coming from Sunderland which was the main source of this trade throughout the century. The Newcastle vessels occasionally brought glass, and salt from the salt pans at Shields(1). The number of vessels bringing cargoes from other ports ranged between 66 in 1705 and 156 in 1717. Generally London supplied the greatest number and always the greatest variety of incoming cargoes. Many boats entered from other Wash ports, especially King's Lynn and Spalding. From the latter, inaccessible to larger vessels, cargoes were brought in barges such as the Lincoln "duddles", and included flax and hemp, typical fenland crops. Lynn, with more foreign trade than Boston, functioned as an entrepôt, sending wine to the latter as wells as cereals and malt from Norfolk. Finally there is an occasional record of a special cargo, e.g. pipe clay from Poole. Coastwise shipments between 1700 and 1710 ranged between 67 and 171. Many of the larger vessels sailed to London with cargoes from the Lincolnshire Fens. There were, for example, many shipments of feathers and quills from the Fen geese. Marshland sheep producing "very lusty wool of a large staple"(2), supplied many of the packs of wool sent across to Lynn for the Norfolk worsted manufacturers. Transhipment at Boston was responsible for the cargoes of naval stores leaving the port in "duddles" for Spalding and Holbeach. All these and other records in the Port Books show that Boston was the supply centre of south Lincolnshire and the outlet for much of its produce.

Precise information on Boston's trade as a market town is not available. There are, however, some comments on the market towns of Lincolnshire in the eighteenth century editions of *Magna Britannia*. Out of a total of 31, only 6 were situated in the Holland division (see Fig. 1), a fact which reflected its large area of ill-drained fen. Furthermore Boston was the only one of the six which was stated to maintain two good markets weekly. Holland produced "little corn, much grass, and plenty of fish and sea fowl", a list mirrored by the description of Boston's market as "well stored with flesh, fish, fowl, etc."(3) Of the population of the town in 1700, nothing definite is known. Nevertheless Boston generally seems to have given a favourable impression of trade and prosperity. Defoe, for example, thought it "a large, populous and well built town, full of good merchants"(4).

(1) "It is a prodigious quantity of coals which those salt works consume ; and the fires make such a smoke, that we saw it ascend in clouds over the hills, four miles before we came to Durham". Daniel Defoe, *Tour through England.*

(2) C. Merret, op. cit., 343.

(3) J. Ogilby, *Traveller's Guide*, 1699.

(4). D. Defoe, op. cit.

Boston at the End of the Eighteenth Century.

By the end of the eighteenth century changes had taken place in Lincolnshire which materially affected Boston. Foremost among these were improvements to the inland waterways. An act passed in 1761 had resulted in the draining of the Witham fens and in the shortening and deepening of the river between Lincoln and Boston. The Fossdyke was improved in the middle of the century and in the last years canals were made from the Witham to Horncastle and Sleaford. In general it seems that inland communication was far more effective than in the early part of the century. Meanwhile Boston harbour and its outfall channel were in acute difficulties. The construction of the Grand Sluice in 1766 resulted, according to several engineers, in the increased silting of the harbour. Furthermore the frequent shifting of the channels in the Wash continued to make access from the sea hazardous. Obviously therefore no amount of improvement of inland waterways could much assist the trade of the port while the sea approaches remained unsatisfactory. It was recorded in 1790(1) that vessels of more than 100 tons could not get further than the Scalp, a channel three miles below Boston. Vessels engaged in foreign trade, some of which were of 230 tons(2), used lighters. The inconvenience of this was no doubt the chief reason for the smallness of foreign trade. During 1792-3, for example, only 20 vessels brought imports.

Records indicate that in spite of the lack of foreign trade, there was a marked increase in shipping towards the end of the century. This was a result of developing coastal trade carried on in vessels ranging from 20 to 85 tons, the receipt of coal and the shipment of foodstuffs accounting for most of the traffic. In 1792-3, for example, 354 ships brought coal, Sunderland sending 328. There was also a new development in the coal trade for barges had begun to bring Yorkshire coal to Boston via the Fossdyke. In the same year 121 shipments to London were recorded, the main cargoes being oats and wheat. By this time Holland Fen had been reclaimed and Arthur Young had recorded a big increase in crop yields on the newly enclosed marshlands bordering the Wash. Thus the change from fen products to cereals found reflection in the changing shipments from Boston to London. An interesting item in the list of agricultural products sent to Hull was woad, cultivated near Boston and sold to West Riding wool dyers. A number of records mention the arrival at Boston of stones, tiles and slates, a reminder of the lack of stone in Holland and the new building going on in Boston. In general it seems that, despite the failure to deal adequately with the disabilities of the port, Boston's coastal trade was growing because of the greater productivity of its hinterland.

Still more was its market stimulated by improvements in agriculture. The enlargement and paving of the market-place was one expression of the town's prosperity. The spring and autumn fairs flourished, for improved stock breeding had made the marshland grazing increasingly productive. But in 1800 there were still large areas of unreclaimed fen north of Boston. During the next decade the draining of East, West, and Wildmore Fens was accompanied by the enclosure of 41,000 acres and a further increase in crops which found their nearest market in Boston. At the same time roads were made and the new drains served as routes for barges. One result of improved communications was that

(1) Philip Luckombe, *England's Gazeteer*, 1790.

(2) See *Boston Corporation Records, Buoys and Beacons Accounts*, 1792.

Boston's market radius was extended while smaller markets declined. Data are not available for a map of the town's market radius in 1800 but information relating to the early nineteenth century is to be found in *White's Directory of Lincolnshire* which first appeared in 1826. Figure 3 shows those settlements which were linked to Boston market by sailing packets or carriers. It is evident that water transport provided a link between the villages on the southern margins of the Wolds and Boston by way of the drains. Packet boats also sailed through Holland Fen to Sleaford. Others navigated the Wash to Spalding, Wisbech and King's Lynn. The market was served by numerous carriers, some travelling from the villages on the higher silt lands, others from settlements on the far side of the fen in Kesteven. In general carriers and sailing packets served between forty and fifty settlements within a distance of sixteen miles from Boston. Beyond this radius some connections were made with market towns up to thirty miles away.

White's Directory throws light on another aspect of Boston's development. Although the town had never been noted for manufacturing, certain small industries associated with the port or with agriculture had arisen and it appears that the growth of Boston as a supply centre had stimulated a number of crafts. Table 1 suggests the high degree of self-sufficiency in consumer goods then attained by the town.

Fig. 3

Table 1.—BOSTON INDUSTRIES, BASED ON WHITE'S DIRECTORY, 1826

Industries connected with the port.		Industries connected with agriculture.		Industries supplying consumer goods.	
Boat builders	3	Basket makers	4	Boot makers	36
Coopers	4	Brewers	14	Cabinet makers	18
Mast and pumpmakers	2	Corn millers	9	Chair makers	4
Rope makers	6	Curriers	3	Cutlers	3
Sail makers	3	Gunsmiths	3	Lace makers	4
		Maltsters	5	Milliners	26
		Saddlers	8	Pattern makers	1
		Tanners	3	Pipe makers	1
		Wheelwrights	5	Stay makers	3
				Straw hat makers	9
				Tailors	6
				Watch makers	8

In professional and cultural life Boston was also developing. It was a banking centre and its theatre, assembly rooms and libraries flourished. Meanwhile the population of the town had increased from 3,470 in 1768 to 5,926 in 1801. During the next twenty years there was an increase of 74% and the population reached 10,373 in 1821.

Boston at the End of the Nineteenth Century.

From this point we may turn finally to a survey of Boston at the end of the nineteenth century. This century which saw the greatest development of industrial towns England had known, brought changes in a less spectacular way to many old centres of which Boston was one. The most outstanding development was the improvement of the port carried out during the last twenty years of the century as a result of several factors. In the first place although certain improvements to the estuary were made between 1825 and 1870 the approaches remained inadequate for large vessels. Their cargoes had to be transferred to barges in the Clayhole Channel, the additional cost making timber, for example, 20/0d. per ton dearer at Boston than at Grimsby(1). In addition there was increasing competition from King's Lynn and Sutton Bridge ports, both of which were equipped with docks before Boston and, during the '70s, were capturing Boston's trade especially in timber and grain. Boston Corporation therefore built a dock. Fortunately there was a large area of open land south of the town adjoining the estuary (see Fig. 4). Excavation in the boulder clay was easy and the work was carried out between 1882 and 1884. The second improvement was the shortening and deepening of the approaches from the Wash. The New Cut (1880-7) provided a direct channel with an additional 8 feet in depth. As a result the size of vessels reaching Boston Harbour increased from a maximum of 300 to 3,000 tons and commerce quickly mounted. Harbour dues rose from £568 in 1880 to £2,574 in 1900(2). Records of the volume and direction of trade are also available(3).

(1) Minutes of Evidence before Select Committee of House of Lords on Boston Dock Bill, 1881.

(2) See Boston Corporation Minute Books.

(3) Annual Statement of Navigation and Shipping of U.K., 1901 (H.M.S.O. 1902)

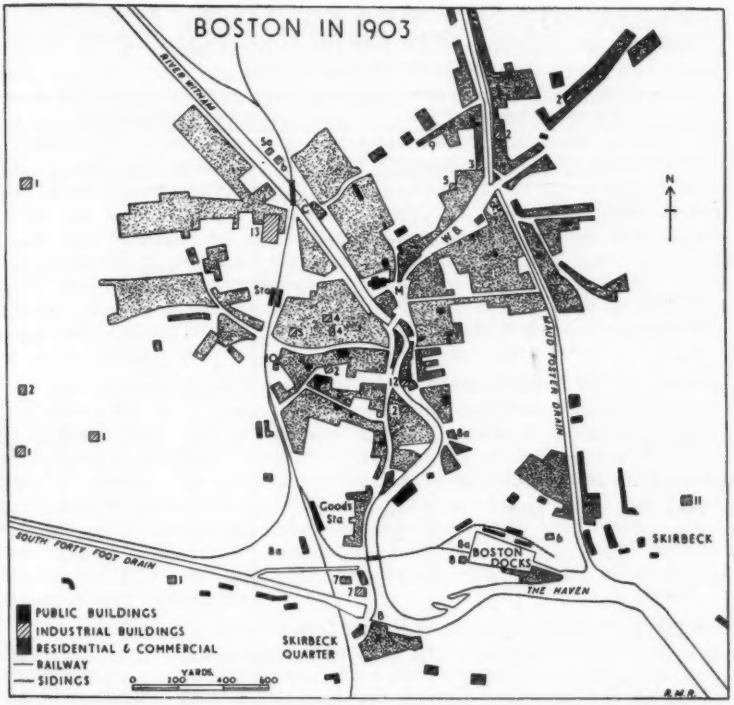

Fig. 4

1	Brick Works	5a	Feather Bed Factory	9	Cigar Factory
2	Corn Mill	6	Iron Works	10	Pea Factory
3	Brewery	7	Oil Mill	11	Wood Mill
4	Malt House	8	Saw Mill	12	Ketchup Factory
5	Feather Mill	8a	Timber Yards	13	Gasworks

B	Black Sluice		
G	Grand Sluice		
M	Market Place		
WB	Wide Bargate		

TABLE 2.—SHIPPING RETURNS FOR THE PORT OF BOSTON IN 1901.

Direction.	Entered		Cleared	
	Vessels	Tonnage	Vessels	Tonnage
(1) To and from Foreign Countries and British Possessions ..	228	86,774	211	73,152
(2) Coastwise	266	20,638	170	48,776
	494	107,412	381	111,928

From these figures given in Table 2, it appears that incoming vessels still exceeded outgoing despite the increased hinterland made available to Boston by railway development. A second characteristic was the preponderance of foreign trade over coastwise. This marked an important change and was due to two main factors, viz., the harbour improvements, and the development of railways which had greatly reduced coastwise trade.

TABLE 3.—SHIPPING RETURNS FOR BOSTON IN 1901 : NUMBER AND TONNAGE OF VESSELS FROM AND TO FOREIGN COUNTRIES AND BRITISH POSSESSIONS.

EUROPEAN COUNTRIES					COUNTRIES OUTSIDE EUROPE				
	Entered		Cleared			Entered		Cleared	
	Vessels	Tonnage	Vessels	Tonnage		Vessels	Tonnage	Vessels	Tonnage
N.W. EUROPE									
Norway ..	69	20,680	37	12,061	Egypt ..	2	2,437	—	—
Sweden ..	5	1,392	11	3,908	U.S.A. ..	2	2,977	—	—
Denmark ..	8	571	40	8,824	Mexico, W. Indies and Central America ..	—	—	1	308
Holland ..	7	1,701	1	55					
Belgium ..	11	5,769	2	917	Argentine ..	2	2,625	—	—
France ..	9	3,049	—	—					
CENTRAL AND EASTERN EUROPE..									
Germany ..	125	46,270	132	50,442					
Russia ..	26	11,978	2	678					
Roumania..	1	1,266	—	—					
SOUTHERN EUROPE.									
Spain and Canary Is.	3	1,916	—	—					

Table 3 shows that though the connection with Scandinavia, so dominant during the eighteenth century was still important, trade at the beginning of the twentieth century was more widespread. The outstanding development was the connection with Germany carried out by a twice-weekly steamer service between Boston and Hamburg. The lists of commodities imported and exported also provide marked contrasts with earlier trade. The chief imports were foodstuffs, sugar, cereals, oilseedcake and potatoes, items which show that the trade even of a small port such as Boston reflected the changed position of England as regards food production. Timber products were second in value, followed by manufactures. The principal export was coal, Boston now being an outlet for the Notts. and Derbys. coalfield and no longer an importing centre. Wool was the second export in value, an interesting reminder of Boston's ancient trade ; third was machinery, particularly steam engines. Such a summary of foreign trade, despite its brevity, suggests that Boston's hinterland had expanded considerably to include industrial districts of the Midlands.

In spite of the general depression in arable farming during the last quarter of the nineteenth century, Boston markets appear to have been fairly prosperous. So little had arable farming declined in Holland that Boston's corn market was said to be one of the largest in the kingdom(1). The fairs also were noted for large sales of cattle, sheep and horses.

It is interesting to see in what ways the varying developments in Boston during the nineteenth century modified the form of the town.

(1) W. White, *Directory of Lincolnshire*, 1892 edition.

For this purpose, Fig. 4 showing Boston in 1903, can be compared with Fig. 2. It is immediately apparent that most growth had taken place in west Boston. This was largely owing to the railway which had found convenient sites for passenger and goods stations on the western margin of the mid-nineteenth century town. In east Boston the chief new feature was the dock and the working-class houses built near it. In general the form of the town had become more symmetrical than in earlier times. The linear pattern following the banks of the Witham was maintained, while the north-eastern extension along the Horncastle and Spilsby roads was balanced by a north-western extension beyond the station along the Sleaford road. Fig. 4 also indicates a small but significant development of industry dependent either on local raw materials, as in the case of the factories processing agricultural products, or on imported materials, notably timber. Thus employment was wider in range than in earlier times.

The population of the borough had grown from 5,926 in 1801 to 16,174 in 1901, an increase of 272% and this, together with 3,649 people in Skirbeck and 975 in Skirbeck Quarter, made it much the largest settlement in Holland. Its growth through the century, however, shows distinct phases. Up to 1851 the increase was rapid, the town growing much faster than the neighbouring villages. In 1851 its population reached 15,132 and remained about this figure until 1891 when it again numbered 15,132. In the last decade a second phase of rapid increase began and this can clearly be associated with the rise of new port activities and industries.

In conclusion it may be said that the essential character of Boston as a small port and market town had not changed in two centuries. Development had been a matter of the improvement of existing functions rather than the growth of new ones. It was seen first in the improved agriculture and communications in the hinterland of Boston and, finally, in the construction of the modern port.

THE 1951 CENSUS: AN ANALYSIS OF POPULATION CHANGES IN DERBYSHIRE

A. G. Powell

The Derbyshire County Report of the 1951 Census published in October, 1954, presents the statistical background of changes in the human landscape of the county since 1931. The inter-censal period was of course twice the normal length and this inevitably makes a true assessment of population trends more difficult. In a number of cases the absolute changes mask variations which have occurred in response to the widely varied economic circumstances characterising the period. It is perhaps worth recalling that these twenty years fall into at least six phases each with economic and social consequences differing materially from its predecessor and each therefore likely to have a different effect upon population movements. These phases are :—

(1) Economic Depression : 1931-1935.
(2) Recovery and Rearmament : 1936-1939.
(3) Evacuation : 1939-1940.
(4) War : 1939-1945.
(5) Post War Resettlement : 1946-1948.
(6) Return towards normal : 1949-1951.

The post-war phases up to 1951 were characterised by an acute housing shortage, with government policy directed primarily to the building of council houses to relieve the congestion existing in each local authority area. This has hampered movements from one area to another by tending to "freeze" population, particularly manual workers, into the areas in which they lived in the immediate post-war years. For these reasons any analysis of inter-censal change must be highly generalised. Detailed and comparable data on parish populations are lacking except for the two census dates. The (unpublished) parish records of the 1939 National Register go some little way towards filling the gap, but they themselves suffer from the margin of error attendant upon any hastily organised count and reflect the highly abnormal conditions existing at the time of the count, 29th September, 1939, when the initial wave of war-time evacuation was at its height and considerable numbers had already moved into the armed forces. This analysis must therefore be confined almost wholly to comparison of the data available in the published volumes of the 1931 and 1951 censuses. The counts were taken on 26/27th April, 1931 and 8/9th April, 1951 and, since schools and colleges were generally on vacation on both dates, the results give the maximum degree of comparability.

Total Changes within the County

The total population of the geographical county increased by 76,226 or 10·2% between 1931 and 1951, i.e. an average growth of 0·5% per annum. This, in common with that for England and Wales as a whole, is a somewhat slower overall rate of growth than the 5·7% increase (40,741 persons) recorded in Derbyshire in the preceding ten year period. This is itself a noteworthy example of the dangers inherent in generalising over a twenty year period. The mid-year estimates show that growth between 1931 and 1939 was only 2·5% (0·31% per annum) while that between 1939 and 1951 was 7.4% (0.62% per annum). The inter-censal increase rate is slightly higher than that for England and Wales (9·5%) but the rate of increase since 1939 is materially greater than that for the country as a whole (5·7%). Such overall trends are those to be expected in a county which lies on the margin of the broad London-Merseyside belt of expanding industry and population—into which southern Derbyshire, at least, is being inevitably drawn. They are also trends to be expected in a county whose economy is dominated, firstly by coal-mining, which suffered from the quota system operating in the thirties but has, since 1939, enjoyed unparalleled prosperity and secondly, by a variety of engineering and miscellaneous consumer goods industries which have either been introduced or have expanded rapidly since 1931.

The effects on the landscape of absolute change in population during the period are camouflaged by the changing trend in family size. It is not possible here to examine this trend in detail but, while in 1931 the average size of family in Derbyshire was 3·9 persons, in 1951 it had fallen to 3·3. There were 55,859 more "private households" in the county in 1951 than there were "private families" in 1931 (the two terms are virtually synonymous) i.e. the number of families had increased by 22·9% while the total population increased by only 10·2%. There were 54,643 or 23·2% more "structuraly separate dwellings" occupied in 1951 than in 1931. The number of families living two or more to a dwelling had risen by 1,200 (18%). In those parts of the county

where the population has increased, the effect of the increase on the landscape is exaggerated, since the number of houses will have expanded more than the population increase would of itself suggest. Even in areas of absolute decline in population, the number of occupied houses is commonly greater than was the case in 1931.

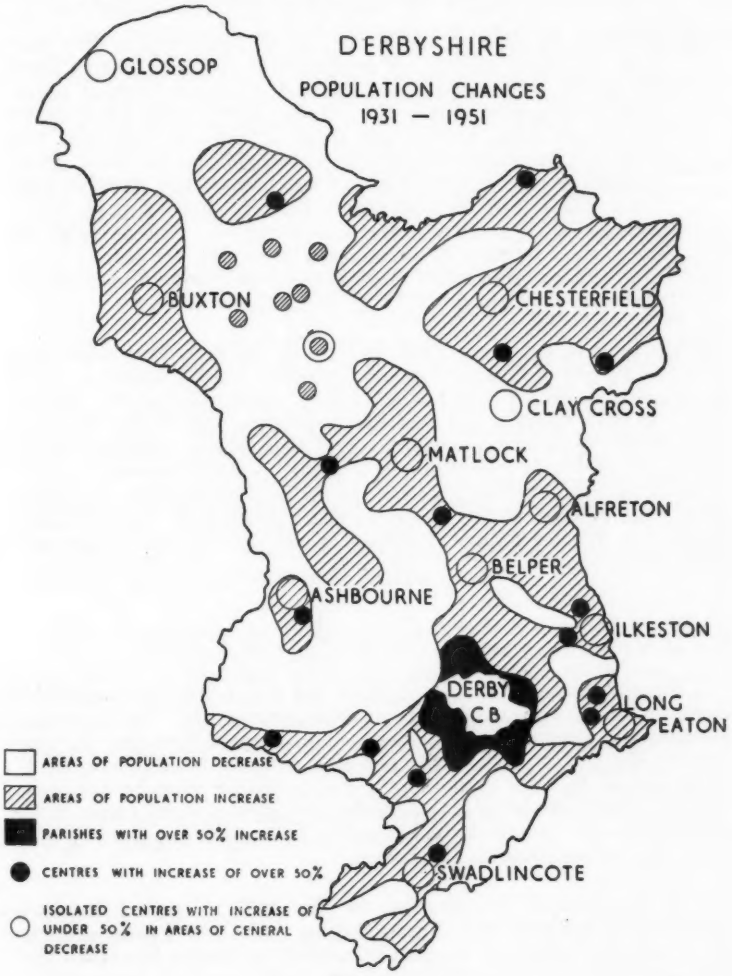

Fig. 1

Natural Change

Actual changes in population in any area are the net result of natural change, i.e. the balance of births over deaths or vice versa, and of migratory movement from one area to another. Considerable natural increases of population have occurred in two types of area in Derbyshire :—

(1) In the coalfield areas of Eastern Derbyshire and Swadlincote where a high birth rate is traditional. All local authority areas within the coalfield sub-regions show a natural increase of over 10% during the period, the highest percentages being in Bolsover (19·7%), Clowne Rural District (16·0%), Chesterfield Rural District (15·9%) and Blackwell Rural District (15·7%).

(2) In those districts on the border of the larger towns into which there has been substantial immigration of young people during the period. Shardlow Rural District shows the highest natural increase of any district in the county (22·3%) due in the main to movement from Derby into new suburbs beyond the town boundary but also due in part to movement into the more easterly parishes of the District from the Nottingham and Ilkeston areas. Long Eaton and Repton Rural District, both with a natural increase of 11%, fall into the same category. It is probable that the natural increase in Chesterfield Rural District results in part from similar "overspill" movements from Sheffield into its most northerly parishes.

The districts in the High Peak and North Western Derbyshire show very low figures of natural increase. Glossop, indeed, shows a natural decrease (more deaths than births) of 2·8% during the period. Between 1921 and 1931, Glossop had a natural increase of only 0·2%. The town now has 33·2% of its population over 50 years of age compared with an average of 26·8% in Derbyshire as a whole. Natural decreases must be expected to spread to other districts in the near future as the population ages. The returns of the Registrar General for 1953 show a natural decrease in Whaley Bridge, Bakewell Rural District and Chapel-en-le-Frith Rural District.

Migration

Natural decrease should of itself not necessarily be regarded as evidence of an unhealthy state in the countryside. In some cases immigration offsets natural losses; in others the increases in man's working life and in productivity per head can lead to an increase in the prosperity of an area even though its population may be decreasing. Migration movements are of considerably greater significance to the geographer and, particularly in areas of immigration, have a more immediate effect upon the landscape.

In Derbyshire, immigration in the 1931-51 period has been concentrated primarily in and around those towns with a prosperous and varied range of industry. A great volume of movement has taken place into the urban area of Derby, the Trent Valley and the lower parts of the Derwent Valley. Here, Shardlow Rural District shows an increase of 62·4% (i.e. 25,600 persons) by immigration alone. Part of it is "overspill" movement from Derby which lost 9·3% (13,200 persons) by emigration, but part is also due to outward movements of people from the Nottingham area into the eastern parishes of the District. Long Eaton (11·8%) and the Rural Districts of Belper (12·9%) and Repton (8·4%) also record considerable immigration.

In the north east of the county, where Chesterfield Rural District shows an increase of 0·7% (4,500) by migration, the whole is probably concentrated into the developing suburban areas of Sheffield. The 9·0% increase in Dronfield supports this conclusion. Elsewhere in the county only Ashbourne, Buxton, Bakewell and Whaley Bridge show growth by immigration. In all cases the increases are substantial and arise from increased industrialisation and from the continued drift from the surrounding countryside. In each case the composition of the population, as given in Table 27 of the Report, shows that the towns are service centres for the surrounding countryside with abnormally high proportions of professional and sub-professional inhabitants. As compared with an average for all urban areas in Derbyshire of 12·8% in the "Professional" and "Intermediate "social classes, Ashbourne has 18·9%, Buxton 20·9%, Whaley Bridge 21·5% and Bakewell 26·4%. In the case of Whaley Bridge the professional element is a dormitory population working in Manchester and Stockport.

Throughout the remainder of the county, emigration movements prevail. All parts of the Coalfield Region, with the exception of Dronfield and Chesterfield Rural Districts show substantial outward movements which reach their highest levels in areas having the least variety of occupations. Blackwell Rural District losing 19·2% (or 8,550 persons), Clay Cross losing 13·2% (1,160) and Staveley losing 13·1% (2,330) are particularly prominent in this respect. Ilkeston shows a 10.8% (3,275) loss by emigration but this part of the Erewash Valley has a wider range of industries and much of the movement from the town is probably of a purely local character and is balanced by movement into expanding villages in neighbouring parts of Shardlow Rural District. Swadlincote shows that the same tendency operates in the South Derbyshire Coalfield : it lost 9·1% (1,875) by emigration, but again much of the movement appears to be local.

With the exception of the four towns already mentioned, the whole of the Peak or Upland Derbyshire shows losses by migration. Bakewell Rural District (3·7%) and Ashbourne Rural District (4·7%) together lost 1,175 persons ; a figure far exceeding the 450 moving into the two market towns. In the High Peak and North Western Derbyshire, Glossop (7·2%), New Mills (4·3%) and Chapel-en-le-Frith Rural District (1·0%) together lost 2,000 persons by emigration as compared with the increase of 1,750 in Buxton and Whaley Bridge. Emigration in these areas becomes of greater significance than that in the coalfields in view of the prevailing low rates of natural increase.

Net Change

It is the net result of natural change and migration as shown in detail in the absolute changes recorded in parishes which reflect the varying trends of human activity in the landscape and are therefore of most significance to the geographer. These changes are summarised on the accompanying map (Fig. 1) and, in terms of the regional sub-division of the county, in the following table.

DERBYSHIRE : ACTUAL AND PERCENTAGE CHANGES OF POPULATION 1931-51, BY REGIONS.

Region	1931	1951	Actual Increase	Percentage Increase	1951 population as percentage of county total
Southern Lowland	53,444	64,613	11,169	20.9	7.8
Greater Derby	165,856	200,364	34,508	20.8	24.2
Derwent Valley	39,895	43,549	3,654	9.2	5.3
Coalfield	338,729	361,313	22,584	6.6	43.7
Low Peak	18,924	19,770	846	4.5	2.4
South Derbyshire Coalfield	31,656	33,043	1,387	4.4	4.0
North West Derbyshire ..	62,901	64,377	1,476	2.3	7.8
High Peak	28,219	28,679	460	1.6	3.5
Peak Fringe	10,587	10,729	142	1.4	1.3
Derbyshire	750,211	826,437	76,226	10.2	100.0

Regional Changes

1. *Greater Derby.*

The scale of growth around the main urban centre is to be expected in view of the prevailing prosperity over the varied field of industry which characterises the confluence area of the Trent and Derwent. The

Fig. 2

period was one of rapid development of the aero-engine, rayon and general engineering industries located here. The trend of suburban expansion at the expense of decongestion of the old core of the town is well demonstrated and has been emphasised by a shortage of building sites within Derby itself. Until recently the Mackworth Housing Estate which is now being developed was without piped water supplies; in consequence, much of the town's post war housing has been built on sites outside its boundaries at Chaddesden, Spondon, Allestree, Littleover, Alvaston and Boulton. The limited growth in Sinfin Moor, and an actual decrease in Elvaston are a reflection that, in spite of their close proximity to the town centre, the low lying land in these two parishes is physically the least suitable for urban development of all the parishes adjoining Derby.

The considerable growth of population in the parishes north of the Derwent extends the urban block of Derby south-eastwards towards Long Eaton and the outer fringes of Greater Nottingham on the one hand and eastwards towards Ilkeston and the Erewash Valley on the other. These trends strengthen the developing "Mid-Trent Conurbation" which, as the late C. B. Fawcett noted has become a geographical reality in the two decades under review(1). It is nevertheless most interesting to find that the attraction of the large towns has had the effect of emphasising a natural "green belt" which still exists between them by producing within it a belt of declining population. This belt is surprisingly complete from Kilburn in the north to Elvaston in the south, and includes both main roads from Nottingham to Derby. It is all the more interesting to find that this is not an isolated example. A similar belt of declining population from Chatsworth through Barlow and Unstone to Killamarsh, broken only at Eckington, separates the expanding suburbs of Sheffield from the less rapid growth in the Chesterfield-Staveley-Bolsover area of the Coalfield. It will be of interest to note how far similar belts appear in comparable areas elsewhere in the country.

2. *The Southern Lowland.*

The lowlands in the confluence area of the Dove, Derwent and Trent have experienced an increase in population proportionately greater even than that in Greater Derby. They show the largest percentage increase of any sub-region in the county. This arises from a variety of causes. Villages nearer Derby, while not yet drawn into the urban block of Greater Derby, are yet sufficiently near to function as middle class dormitories. Long Eaton and the adjacent parishes of Breaston, Risley and Sandiacre have expanded rapidly in response to continued industrial growth in the lower Erewash Valley and also as dormitory suburbs for the Greater Nottingham area. Greater Nottingham, in view of the industrial development of the Trent valley in Beeston and Chilwell since 1931, has now reached Long Eaton and produced an urban area which overlaps the Derbyshire boundary. Similar dormitory settlement from Burton-on-Trent is affecting the parishes fringing the town. Elsewhere this region is characterised by increases along the main roads, notably between Derby and Uttoxeter and by growth attendant upon either the establishment of new industries e.g. the gravel workings at Hilton and Willington or upon the introduction of new institutions e.g. the open prison at Sudbury.

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(1) C. B. Fawcett, in a discussion following "The Doctrine of an Axial Belt of Industry in England", *Geog. Journ.* CIII, 1944, p. 64.

3. *The Derwent Valley.*

The influence of industrialisation and urbanisation extends northwards from Derby in a narrow belt of population increase reaching to Rowsley. Population growth here is related in part to dormitory settlement from Derby but in the main to the expansion of employment in the metal and hosiery industries of Belper and Matlock. Several metal firms moved into this sub-region as a war-time measure and have remained. The highly localised increase in Alderwasley parish is a sign of the times covered by the period. It is the result of a riverside caravan camp established at Whatstandwell which remains permanently occupied in view of the housing shortage.

4. *The Coalfield.*

The Coalfield contains nearly half the total population of the county. Population changes within it vary in relation to a number of different stimuli. In the north, dormitory settlement from Sheffield has led to an expansion of Dronfield, while Sheffield Corporation and private housing estates at Gleadless and Frecheville have produced the high percentage increase in Beighton parish. Southwards from this belt of expansion, which is itself unconnected with mining activity, lies the belt of declining population already mentioned which separates the Sheffield and Chesterfield areas.

The Chesterfield-Staveley-Bolsover area has a variety of expanding industries in addition to the collieries themselves and population increases are common over an east-west belt some six to eight miles in width. Chesterfield in particular offers employment opportunities for men and women drawn from a wide radius and considerable increases in population have occurred both in the town itself and in the adjacent parishes, notably in Wingerworth, which has proved particularly attractive to private house builders. The significance of the Brimington Anticline is also evident in the increase in Calow and Brimington parishes. The anticlinal structure has led to the removal of workable coal seams and therefore produces one of the very few areas of stable land suitable for large scale house building in a broader area characterised by an unstable surface arising from the working of coal at relatively shallow depths. At Glapwell, pre-war colliery housing is responsible for a high percentage increase of population. Between Chesterfield and the Erewash Valley is an area depending almost wholly upon mining and agriculture. It has naturally suffered from emigration and a fall in population. Evidence on the movement to work of miners suggests that considerable numbers of miners themselves may have left the colliery villages and settled in the nearby towns of Chesterfield, Mansfield and Sutton-in-Ashfield where a wider range of educational, shopping, entertainment and employment facilities is available for their families and from which the collieries can be reached fairly easily by bus. Clay Cross, the only true township within this belt, continues to lose population as it has done since 1921.

The Erewash Valley towns of Alfreton, Ripley, Heanor and Ilkeston show moderate growth in sympathy with the increased prosperity of the local collieries and the introduction of some additional non-mining industry. There is a tendency, especially since the war, for women to find employment in new factories nearer their homes.

5. *The South-Derbyshire Coalfield.*

The small but very distinctive regional entity consisting of the coalfield centred on Swadlincote shows a lower rate of increase than the main East Derbyshire Coalfield. This region is heavily dependent upon the basic industries of coal and fireclay mining. The large numbers of small collieries existing before 1939 have been combined into fewer and more efficient units with an economy in man-power and a consequential rise in output per head to a level higher than that in any other part of the country. The highly industrialised environment is the worst of its kind in the East Midlands and proves unattractive both to new industry and to new residential development. Mining subsidence arising from the underground working of shallow seams of both coal and fireclay is acute and adds to the problem of attracting new development. Stable land does however exist in adjacent parishes to the east where the Boothorpe Fault separates the workable from the unproductive Coal Measures. In this area, notably in Hartshorne parish, population increases are associated with new housing development conveniently situated in relation to the industrial zone which has been built by the Swadlincote and Repton District Councils and by private builders.

6. *The Low Peak.*

As compared with the prevailing increases characteristic of the lower lands in the south and east of the county, Upland Derbyshire shows a pattern of localised increases set against widespread decreases in the purely rural parishes. For convenience, this part of the county is considered in relation to its four main sub-divisions—the Low Peak, the High Peak, the Peak Fringe and north-west Derbyshire.

As regards the Low Peak, the considerable expansion in and around Ashbourne arises partly from new industrial development and partly from its increasing significance as the market and general service centre. Ashbourne presents a good example, also evident in Bakewell in the High Peak, of movement into the town, especially, it would seem, from parishes only quite short distances away.

A curiously anomalous belt of slight increase in population covers nine parishes lying diagonally across the Low Peak from north-west to south-east. It is difficult to suggest why this should be. Apart from the silica firebrick factory at Newhaven and gravel workings at Hulland and Kirk Ireton, all of which lie on its margins, the area is virtually devoid of industry. It is related to no important line of communication and consists of small villages, mostly with below 200 inhabitants and with Parwich alone having over 500. Even so the larger parishes show the smallest increases. The circumstances appear to be those which almost invariably produce a fall in population. The only possible explanation which can be advanced, and then with some diffidence, is that this remote area has found its access to the Derwent and Dove Valleys improved since 1931 by road developments and the use of motor transport and that in consequence the old "butter and cheese" economy of this part of the Peak has given place to a more stable and prosperous agriculture based on the export of liquid milk to the new dairies at Rowsley and Ashbourne. This may have caused a population which had previously reached a near-absolute minimum for agriculture to increase again. The remaining parts of the Low Peak reveal the decreases which would be expected in an upland agricultural area where alternative employment is limited and where increased mechanisation has reduced the need for agricultural labour.

7. *The High Peak.*

Changes in the High Peak reveal three groups of population increase against a background of decline. The parishes of the Hope Valley show the consequential increases to be expected following the establishment of the cement works between Hope and Bradwell. These two villages, together with Castleton, show the largest numerical increase (645 persons) but the effect of the new industry is reflected in a group of eight parishes extending from Edale to Bamford which have expanded by 24% (985 persons) since 1931. A group of parishes in the Upper Derwent Valley extending from Baslow to Hathersage has grown by 11% mainly as a result of dormitory settlement from Sheffield. Elsewhere increases have occurred in a number of scattered parishes on the limestone plateau. The villages concerned (Eyam, Great and Little Longstone, Youlgreave and Taddington) are the larger settlements, averaging 630 population, with the better facilities for servicing the surrounding countryside. They have increased on average by about 6%. New quarrying activities have assisted growth in some places, e.g. Eyam (fluorspar) and Weston (limestone).

The smallest villages on the other hand show marked declines. In addition to the parishes of Derwent and Hope Woodlands where flooding of the Derwent Valley to form the Ladybower Reservoir caused a big displacement of population (mainly re-housed in Bamford parish), eight other parishes scattered over the limestone plateau each lost over 25% of its population. They are essentially the smallest parishes, many being without any recognisable village nucleus and are now left with an average size of only 64 persons.

8. *The Peak Fringe.*

This division comprises the eastern moorlands from Sheffield southward to the Amber Valley and is both the smallest unit within the county and that having the least proportionate overall increase. Apart from suburban development around Sheffield and Chesterfield, populations have generally declined in an area characterised by moorland farming and declining employment in both gritstone and limestone quarries.

9. *North-West Derbyshire.*

Standing high on the western flanks of the Peak, North-West Derbyshire looks westwards towards south Lancashire for its economic contacts rather than to the main Derbyshire axis of the Derwent and Trent valleys. As a region it shows a surprisingly small increase in population in view of its urbanised character. General decreases are common in the areas north of Whaley Bridge and Chapel-en-le-Frith where high altitude and relatively difficult access militate against additional economic activity. Low birth rates and emigration are characteristic. Derbyshire County Council have proposed to remedy the declining economy and falling population of this part of the county by importing "overspill" population from south Lancashire. To the south, the Buxton-Whaley Bridge area is increasing as a result of dormitory development and the increasing concentration within it of limestone quarrying. This latter is itself a reflection of the nation wide trend towards specialisation which typifies the 1931-51 period and which has concentrated limestone workings on the outcrops of high chemical purity around Buxton.

Conclusion

The outstanding feature of the 1931-1951 population changes in Derbyshire is the confirmation of the significance of urban industry in determining population trends. While those broad belts of the county dependent upon a very narrow range of occupations show almost stationary or declining populations, the towns and urban groups offering a wide variety of employment are expanding rapidly. The momentum of their prosperity is itself attracting expansion of existing industry and the growth of new and ancillary industries together with an absolute and relative increase in the number of service trades and professional workers. Even so, it is somewhat surprising to find that the rapid improvements of motor transport since 1931 have caused so limited a spread of urban and suburban population into the rural areas and that, in consequence, even the increased population of Greater Derby remains strongly localised within four miles of the town centre.

POWER PRODUCTION AND THE RIVER TRENT

E. M. Rawstron

In 1939 there were only two electricity generating stations on the banks of the Trent between Burton and the Humber. These were established at Burton and Nottingham expressly to supply those towns. Their combined capacity amounted to no more than 118,500 kW and they produced only 334,337,000 units (kWh) in 1939. The Trent was of little importance therefore in providing sites for electricity production ; the power stations of the East Midlands as a whole produced current almost entirely for local consumption, and the coalfields of the region besides supplying local power stations sent much coal by rail to stations in other parts of the country. No attempt was made in designing the original "Grid System" to allow for the large-scale export of current from coalfield power stations to distant consuming centres. Until this was envisaged the Trent as a major national source of cooling water could be of only incidental use to the electricity supply industry.

Today the scene is being rapidly transformed. Between 1947 and 1965-70 an enormous construction programme has been planned for the banks of the Trent below Burton. Probably 4,700,000 kW of new plant and possibly as much as 5,900,000 kW are to be installed. This is indeed a vast expansion equal to more than half the installed capacity of steam-driven stations in the entire country in 1939. By 1970 it may amount to perhaps a fifth or a sixth of the national capacity, and the output of this belt of stations should be not less than 25,000,000,000 units (kWh) annually, which is almost equal to the entire national output in 1939.

These statistics take developments on the river well into the future, but even if more immediate plans are considered, the capacity to be installed is still huge. It amounts to considerably more than the T.V.A. and is likely to be the greatest installation of generating capacity on any equivalent length of non-estuarine river anywhere in the world. The stations now being built or scheduled for construction in the near future are Drakelow (near Burton-on-Trent) 720,000 kW., Willington (between

Burton and Derby) 400,000 kW.(1), Castle Donington (near Derby) 600,000 kW., Nottingham about 300,000 kW., Staythorpe (near Newark) 720,000 kW., and Keadby (near Scunthorpe) 360,000 kW. These amount in all to 3,100,000 kW. The first half of Staythorpe is nearing completion, the second half is subject to approval. Initial sections of Drakelow and Keadby are already in use as is the greater part of the Nottingham station. The construction of Castle Donington is well in hand but little progress has so far been made at Willington. At least two further

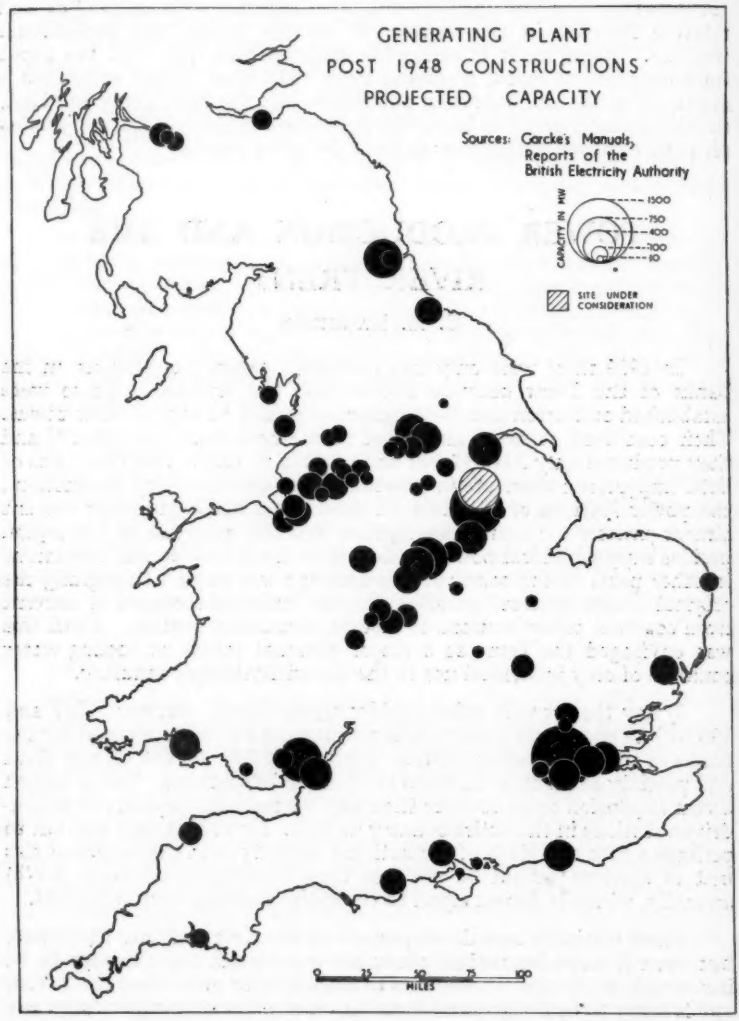

Fig. 1

(1) It is possible that Willington may be developed as a much larger station than is stated here.

potential sites remain for use by large stations between Newark and Keadby and it is almost certain that if these come to be used they will carry stations larger than any powered by coal in the world.

Figure 1 clearly shows the comparative importance of the Trent Valley for power production, even though some of the stations are represented as having capacities smaller than those ultimately intended. It will be noted too that the Trent developments are anomalous in that they do not correspond to the population pattern as do the other major concentrations of stations, e.g. London, South Wales, Birmingham and district, Lancashire and west Yorkshire, the North-East Coast and central Scotland. Nor do most of the stations along the Trent correspond in position to individual towns as do very many of the stations in other parts of the country both within and outside the major concentrations of population.

This twofold geographical anomaly presents a twofold problem for examination. The first part is to account for the anomalous relationship between power developments on the Trent largely in the East Midlands and the market for current (which amounts in broad terms to the population pattern). The second is to account for the anomalous relationship between the location of stations and the location of towns within the East Midlands itself.

Because the technical economies(1) obtainable year after year through the improvement in the design of generating equipment are now much reduced in scope, the electricity authorities have been forced to turn to locational economies in order to achieve the lowest possible costs of production. These are economies which, given the technical environment of the time, result directly from geographical circumstances, i.e. the distance between source of fuel and market for current. In a properly organised supply system it is cheaper to transmit base-load current from coalfield to market than to transport coal by rail to base-load power stations situated in the market areas, provided the distance is greater than about 50 miles. This does not apply where water transport is adequate and competes with transmission.

The only areas in Britain where conditions are fully satisfied for economical electricity export by transmission are the East Midlands and to a less extent the coalfield area of Yorkshire (Fig. 2) (2). For it is here that coal is most cheaply produced(3), output is increasing more rapidly than elsewhere, the coal is of the right kind for electricity generation and water transport is inadequate. At the same time it must be stressed that coalfields (e.g. Northumberland and Durham, South Wales, Fife and Lothians) where water transport is adequate either produce coal too valuable for use in power stations or produce insufficient coal of the right kind. This last point is fundamental. The coal producers are being forced to turn more and more to the interior low-cost fields to increase the national output and the electricity industry must do likewise. If London, the south of England and coal deficit areas

(1) These resulted in the increased thermal efficiency of each successive new plant constructed so that the newest stations at any time usually generated the cheapest current.

(2) Fig. 2 shows comparatively the cost of coal for a representative group of power stations in 1947-48. The tall black columns indicate stations where coal is cheapest, the tall unshaded columns the converse.

(3) See *East Midland Geographer*, June, 1954, pp. 20-23 for a brief note and three maps on coal production.

generally (included here is Lancashire) are to be supplied with sufficient cheap electricity, transmission from base-load stations in the East Midlands and Yorkshire must be undertaken. Mid-load and peak-load current, however, must still be produced as near as possible to the consuming centres(1).

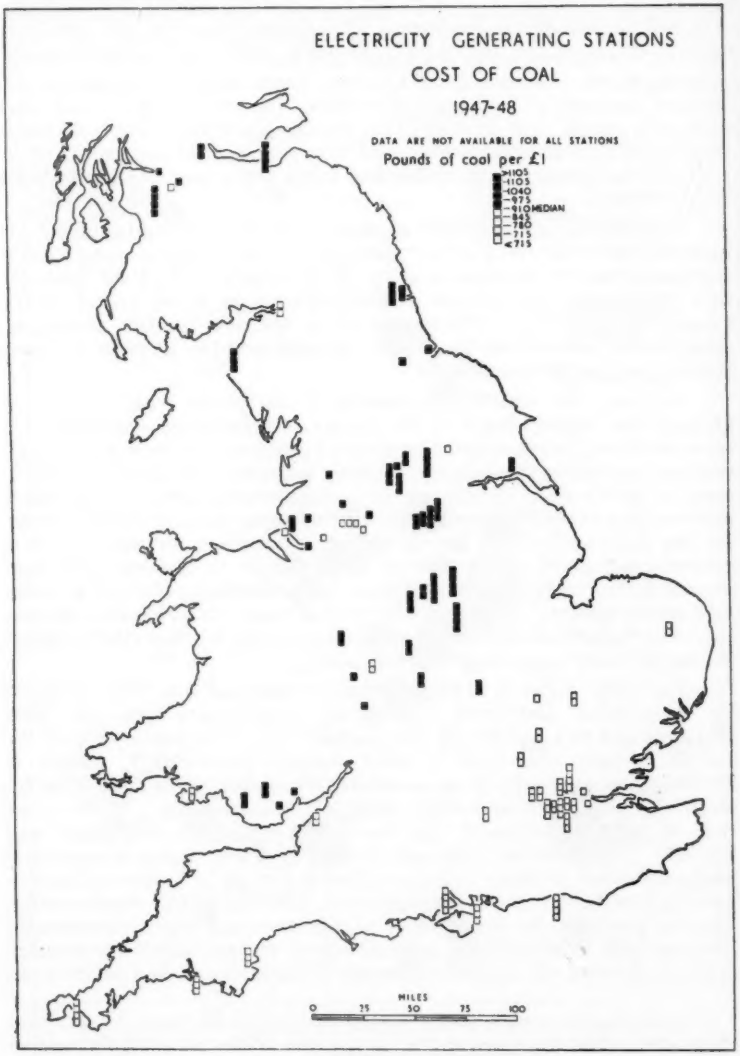

Fig. 2

(1) Base-load current is that proportion of the load supplied at all times of the day. Mid-load current is roughly speaking the daytime load in excess of the base-load. Peak-load is normally of short duration, occurring between 8 a.m. and 12 noon, and around 5 p.m. to 6 p.m. in winter, and about noon in summer. Clearly transmission of base-load current makes better use of the capital invested in transmission lines.

These reasons determine that the general location of a large group of base-load generators must be somewhere near the inland expanding coalfields. Water supply determines that the more detailed location should be the River Trent (also the Aire and Calder in Yorkshire). Power stations using steam turbines are most efficient if such large quantities of cold water are available that cooling can be achieved without the use of cooling towers(1). It is generally accepted that 2+ million gallons of cooling water an hour are required for every 6,000 kW of plant in use. A station of 300,000 kW capacity therefore will need more than 10 and probably between 12 and 15 million gallons an hour when on full load. Thus to avoid unnecessary capital expenditure on cooling towers and a slight reduction in efficiency the Trent is the obvious location for base-load stations dependent on East Midlands coal.

But many of the stations along the Trent will be too large for the river to provide direct cooling facilities. Drakelow, Willington, Castle Donington, the second half of Staythorpe and the two potential sites between Newark and Keadby will each need cooling towers for part at least of their installed capacity. Even so evaporation and spray losses from cooling towers and water demands for ash removal and other purposes are large enough to warrant sites adjacent to the river for such large installations. In any case appreciable economies are achieved if only part of a station is directly cooled.

It is therefore clear that the new power developments on the Trent are related to local coal supplies, water supply and a much larger market than the East Midlands. There need therefore be no locational relationship between stations and towns in the East Midlands. Each station will produce far more current than an adjacent town could consume, even Nottingham.

Thus so far as the second anomaly is concerned it remains only to explain the detailed location of the stations along the river (Fig. 3). Three requirements have to be met by the detailed location; water supply, means of coal supply and space for plant and ash disposal.

Water supply in this respect is a problem of spacing along the river so that the heating of the river water through abstraction for cooling does not (*a*) jeopardise the efficiency of the next station downstream and (*b*) excessively disturb the natural condition of the river water. The stations are therefore spaced at fairly regular intervals and although direct cooling is to be used as much as technically and legally possible, it will be appreciated that it must depend not only on the amount of water regularly available at any point but also on the effect stations further upstream have on the temperature of the water at stations nearer the mouth.

The problem of cheap cooling facilities is an intricate one, fraught with technical and legal difficulties. It is to be hoped that the electricity industry will not be so hedged in by legal requirements that the technical

(1) Two systems of circulation are used in power stations. First there is the boiler-turbine system which is entirely closed. Secondly there is the cooling water system which by condensing the steam as it leaves the turbine creates a vacuum that increases the force of the steam passing through the turbine. The cooling water system itself can be either open or closed. It is open if the cooling water is pumped from river, sea, canal or lake, and after passing through the condensers is returned in the case of a river further downstream. It is closed if the cooling water circulates through cooling towers before passing once more through the condensers.

solution must result in higher costs than might otherwise be incurred: for the Trent scheme is of great importance in the plans to provide the electricity so necessary to sustain and enhance Britain's competitive position in world markets.

Coal comes to these inland stations mainly by rail. All the stations on the Trent are sited (Fig. 3) either where railways cross the river—Castle Donington, Keadby and the two prospective sites on the Lower Trent—or near junctions with the Trent valley line—Drakelow, Willington, Nottingham, Staythorpe(1). On Fig. 3 the collieries are also marked and a rough indication of the source of coal for each station can be inferred. Short distance access to coal applies in every case although there are local problems with regard to rail transport(2).

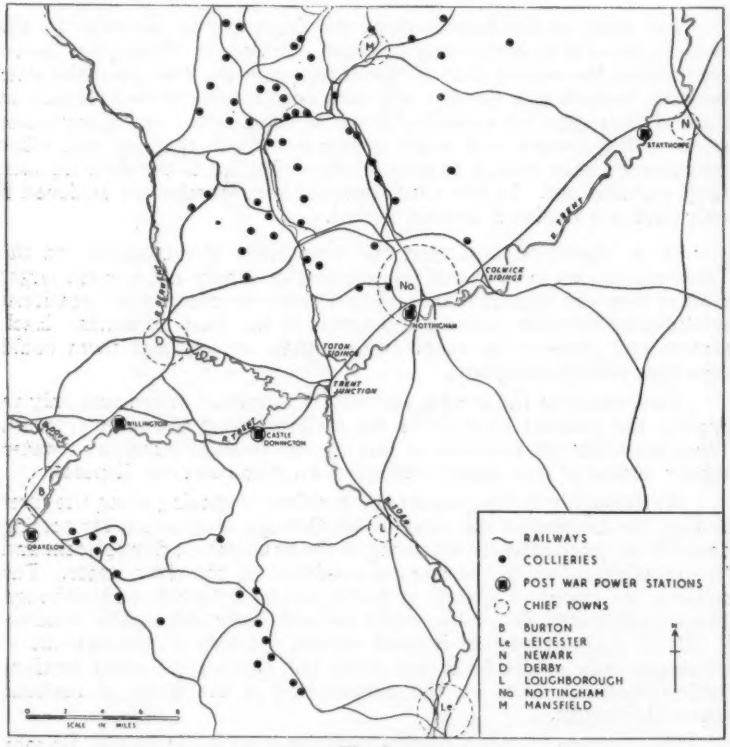

Fig. 3

Post-war Power Development on the Middle Trent.

Space for plant, coal storage and ash disposal is a further limiting factor. This depends however not only on the size of station but also on the type of boiler plant installed. Pulverised fuel firing is the chief

(1) Only the more important section of the river as regards present developments is shown on this map. Some of the stations fit into both categories named above.

(2) The amount of coal used by any of these stations will be very large. The weekly needs of a 300,000 kW. station working at about 85% load factor is about 21,000 tons. The maximum day's consumption may be 3,500 tons.

method used and requires more space for ash disposal since the ash cannot be sold or given to contractors willing to remove it for road making and similar uses. At present plans are to fill disused gravel workings with such ash (as at Drakelow) or simply to raise the level of the flood plain (as at Nottingham). It is a considerable problem because of the large quantities involved(1). Already plans are being considered in other parts of the country to use the ash as a filler in brick making but this is unlikely at present in the Trent valley. Other solutions are constantly being sought.

The remaining space requirements are fairly easily satisfied provided sites are chosen away from built-up areas. Agricultural interests and gravel resources must also be carefully considered.

The Grid System.

It is appropriate here to mention how the Trent valley developments fit into the new "Super Grid" system, without which they could not take place on so large a scale.

Unlike the original "Grid" the "Super Grid" working at 275,000 V is intended in part to provide unidirectional transmission facilities of large capacity. These focus on the Trent valley and to a smaller extent on west Yorkshire, for it is in these areas that regular, almost one might say continuous, exports are planned to originate. Base-load current will be exported to London, southern England generally and to south Lancashire.

The Trent valley stations will be linked by a major grid line and, by means of main transmission lines connected to this, supplies will be sent to the importing areas already mentioned. Lines will go from Drakelow to Carrington (near Manchester) to supply part of Lancashire's needs, from Drakelow via Hams Hall (2) (near Birmingham) to Gloucester and Melksham to supply some current to the south-west, from Castle Donington there is to be a line to Slough and from Staythorpe a connection to Elstree. The Trent valley, roughly in the centre of industrial England, will thus form the hub of what is even now the largest inter-connected electrical system in the world.

Conclusion.

The policy of increasing investment in the public electricity system has lately suffered much criticism and will doubtless continue to do so. But developments along the Trent must be excluded from this argument: for here is the cheapest and most suitable coal ; the current produced is to be base-load and generation costs must therefore be at their lowest when compared with alternative locations. Transmission of base-load current is cheaper than rail transport of coal, thus the cheapest possible base-load current will be available to the consumer. Under these conditions those who control the industry are making the wisest use of their funds by investing in the "Super Grid" and the Trent-side stations.

(1) The ash content of the coal may exceed 15%.

(2) The expansion of the already large installations at Hams Hall really fits in with the Trent valley developments. The site and location of Hams Hall are but little inferior to those of the Trent-side stations.

Within the technical setting of our time the developments along the Trent are based on firm econo-geographical principles. The Trent is today the optimum location for electricity generation. This will cease to apply only when the technical setting changes with the introduction of nuclear power or possibly with the economic development of the coal-fired gas-turbine.

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POPULATION CONCENTRATIONS AND CONURBAN TENDENCIES IN THE MIDDLE TRENT COUNTIES

R. H. OSBORNE

Derbyshire, Leicestershire and Nottinghamshire together constitute two-fifths of the combined area of the six East Midland counties, but they contain 2·30 millions, or two-thirds, of the region's total population of 3·45 millions. Of this proportion almost a half is found in the three largest East Midland towns of Derby, Leicester and Nottingham and their suburbs, which have a total population of about one million, while a further 600,000 persons live in the East Derbyshire and Nottinghamshire coalfield, excluding Nottingham. There is, therefore, not only a regional concentration of population in the Middle Trent counties—as Derbyshire, Leicestershire and Nottinghamshire may collectively be termed—but also a high degree of local concentration within these counties.

POPULATION DISTRIBUTION

This latter feature may be seen from Fig. 1, where the distribution of population in 1949 is shown on the basis of one dot to one hundred persons for places with less than 950 inhabitants and by circles of solid

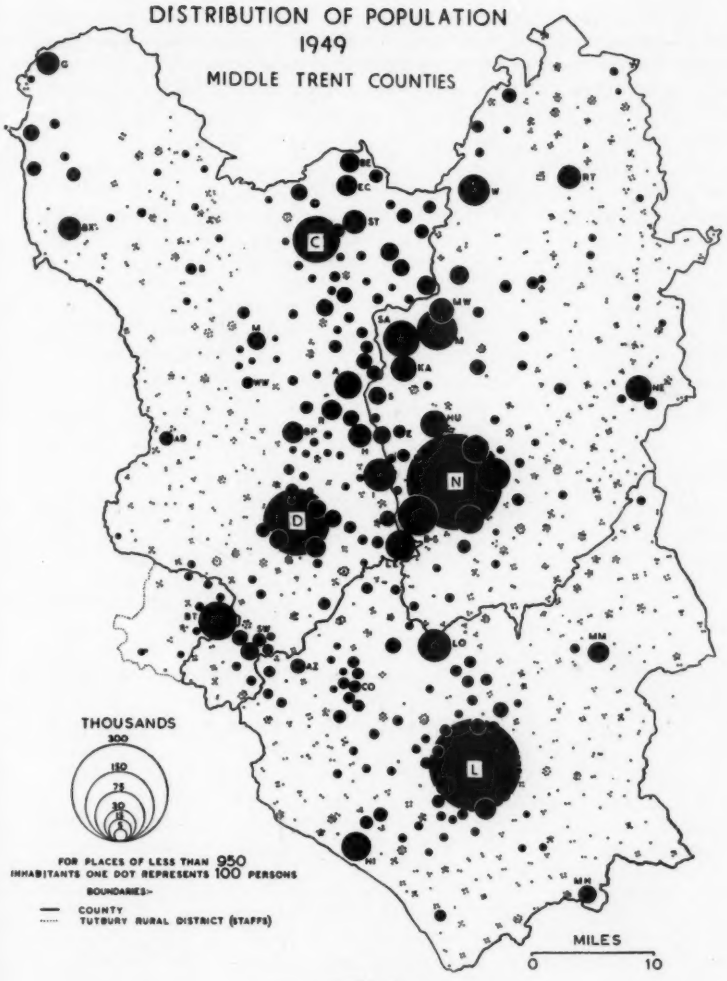

Fig. 1

KEY TO PLACES NAMED

Derbyshire : A—Alfreton, AB—Ashbourne, B—Bakewell, BE—Beighton, BP—Belper, BX—Buxton, C—Chesterfield, D—Derby, E—Eastwood, EC—Eckington, G—Glossop, H—Heanor, I—Ilkeston, LE—Long Eaton, R—Ripley, S—Selston, ST—Staveley, SW—Swadlincote, WW—Wirksworth.

Leicestershire : AZ—Ashby-de-la-Zouch, CO—Coalville, HI—Hinckley, L—Leicester, LO—Loughborough, MH—Market Harborough, MM—Melton Mowbray.

Nottinghamshire : B-S—Beeston and Stapleford, HU—Hucknall, KA—Kirkby-in-Ashfield, M—Mansfield, MW—Mansfield Woodhouse, N—Nottingham, NE—Newark, RT—Retford, SA—Sutton-in-Ashfield, W—Worksop.

Staffordshire: BT-Burton-on-Trent.

shading with areas proportionate to population-size for larger centres(1). The Burton-on-Trent salient of Staffordshire is included with the three counties in view of its close connections with Derbyshire(2).

Derby, Leicester and Nottingham, with their surrounding residential suburbs and industrial satellites, immediately stand out as the main foci of population. A conservative delimitation of "Greater" urbanised areas for these three suggests respective populations of about 190,000, 330,000 and 455,000. Along the southern half of the Derbyshire-Nottinghamshire border stretches the densely-populated Erewash valley, the inhabitants of which are employed to a large extent in coal-mining, iron manufacture and the lace and hosiery industries. The northern and central parts of the valley and its immediate neighbourhood (including Alfreton, Eastwood, Heanor, Ilkeston, Ripley and Selston) have a total population of about 140,000. The southern part, which lies off the coalfield, has a population of about 35,000 on the Derbyshire side in Long Eaton and district, and of about 50,000 in Nottinghamshire in the amorphous Urban District of Beeston and Stapleford (considered above as part of Greater Nottingham). The valley of the Derwent is also well-populated, with a succession of large villages extending upstream from Derby as far as the cotton and hosiery town of Belper.

Lying to the north-east of the head of the Erewash valley is an urban group consisting of Mansfield, Mansfield Woodhouse, Kirkby-in-Ashfield and Sutton-in-Ashfield. This group has a population of about 130,000 and engages chiefly in coal-mining and hosiery manufacture. North of Mansfield is the market-town, industrial and mining centre of Worksop, while to the west, over the Derbyshire border, is the populous Rother basin with its coal-mines and iron-works, dominated by another urban group based on Chesterfield and Staveley. This has a population of nearly 100,000.

There is thus a marked concentration of population in an approximately rectangular area, about thirty miles long by about fifteen miles wide, which runs southwards from the Yorkshire border as far as Derby and Nottingham, and which is, of course, largely coincident with the East Derbyshire and Nottinghamshire coalfield. It may be considered as being bounded on the west by a line from Chesterfield to Derby (passing near the western outcrop of the coal-measures) and by a line from Worksop to Nottingham on the east (passing near the western outcrop of the Bunter Sandstone). To the west an extension is provided

(1) Population figures for 1949 were the most recent available when compilation of the map was begun. For areas with urban status the Registrar-General's mid-1949 estimates have been used, while for civil parishes the author has calculated approximate populations by multiplying the number of electors by the ratio of the total population of the parent rural district to its total electorate. In some instances, however, populations have been split by estimate to allow the separate representations of places which have been amalgamated administratively but where fusion of settlement is absent or only moderate.

It should be noted that only about one-quarter of the boroughs and urban districts had estimated populations in 1949 which differed by more than $\pm$ 2% from the preliminary figures of the 1951 census. Census figures for parishes are still not to hand at the time of writing. It is clear that the general pattern would certainly not be affected by any revision of the map in accordance with the 1951 figures.

(2) Burton is a service centre for the South Derbyshire coalfield and is itself dependent on Derby, eleven miles away, for facilities of a higher order. It was included in the "Trent" (i.e. East Midland) region advocated by C. B. Fawcett in "Natural Divisions of England", *Geographical Journal*, XLIX, 1917 and in *Provinces of England*, 1919.

in the Matlock-Wirksworth district of the mid-Derwent basin, while to the east, in the formerly thinly-settled Bunter Sandstone country, a number of new colliery villages dating from the 1920's can be considered as an eastward advance of this populous zone.

South of Derby and Nottingham the continuity of this zone is to some extent preserved in a skeletal fashion by the quadrilateral Burton-on-Trent—Loughborough—Leicester—Hinckley. The brewing town of Burton and the villages of the South Derbyshire coalfield, including Swadlincote (which gives its name to a composite Urban District), together form an urban group with a total population of about 95,000. On an unproductive anticline to the east is the market-town of Ashby-de-la-Zouch, while eastwards again lie the mining centres of the Leicestershire coalfield, most of which are grouped in or round the Urban District of Coalville, though others lie to the south-east in the newer part of the field. In the lower Soar valley, beyond Charnwood Forest (revealed on the map as a blank patch), are the hosiery and engineering town of Loughborough and a number of large villages which owe much of their development to the hosiery industry. Between Leicester and the heavily specialised hosiery town of Hinckley on the Warwickshire border, are more large villages dependent on the manufacture of hosiery and/or footwear.

To the east and west of these central zones lie less well-populated agricultural areas typified by widespread village settlement, although in Leicestershire and Nottinghamshire there are also several market-towns with a considerable industrial element, viz. from north to south, Retford, Newark, Melton Mowbray and Market Harborough. In western Derbyshire however the market-towns of Bakewell and Ashbourne are by comparison very much smaller. In north-west Derbyshire, Buxton spa and a group of cotton towns in the valleys of the Etherow and the Goyt, including Glossop, may be regarded as part of the Greater Manchester urban region. The High Peak uplands separate this district from the villages of the upper Derwent, these being, in their turn separated from the Rother basin by the gritstone spur of the East Moor.

Conurban Features

This impression of population concentrations within the Middle Trent counties is reinforced by Fig. 2 (which should ideally be superimposed on Fig.1), where two *conurban* features are shown in combination. No recognised conurbation falls within the area shown on the map, although C. B. Fawcett did on at least two recorded occasions recommend the admission of a Derby-Nottingham (or "Mid-Trent") conurbation to the list commonly accepted by geographers(1), his argument resting on the inter-war consolidation of continuous urban landscape linking the two towns. The degree of linkage was not, however, thought to be sufficient in P.E.P.'s *Report on the Location of Industry*, which termed the area an "urban region" and not a conurbation ("urban cluster") (2).

(1) In a discussion following "The Doctrine of an Axial Belt of Industry in England" by J. N. L. Baker and E. W. Gilbert, *Geographical Journal*, CIII, 1944, p. 64, and in a review of *Conurbation*, *Geographical Journal*, CXIII, 1949, p. 99.

(2) "The urban region may be distinguished from the urban cluster by the fact that the various towns concerned, although fairly close and intimately linked by daily interchange traffic, are not physically merged in a single built-up area." (Political and Economic Planning, *Report on the Location of Industry in Great Britain*, 1939, p.167).

There is, in fact, a lack of unanimity on the part of geographers and others regarding the essential characteristics of a conurbation. Sir Patrick Geddes, who first introduced the term, used it to denote a fairly wide area: the urbanised region might be a more accurate description of his loosely-defined concept, which appears to be based on a consideration of major zones of high population density. C. B. Fawcett, however, used the term in a narrower sense and adopted the rigid criterion of continuous urban landscape. While high population density and physical linkage may be two of the most convenient criteria it would seem that economic and social integration have now received a greater recognition, particularly as the result of the intense development of passenger road transport in recent decades and its cheapening relative to income levels.

The conurban features mapped in Fig. 2 are based essentially on the approaches of Geddes and Fawcett however and show (*a*) areas of high population density and (*b*) lines of continuous urban landscape. For the former a minimum density of 500 persons per square mile was adopted, since densities higher than this are frequently associated with urban or semi-urban development. All boroughs and urban districts in the area have densities exceeding this figure. Of the parishes falling into this category only four of very small extent have less than 1,000 inhabitants, though there are on the other hand some fifty parishes of more than 1,000 inhabitants where the large size of the parish produces a density of less than 500. The pattern of densely-populated areas shown on the map therefore depends to a certain extent on fortuitous differences in size of parish.

Compared with density of population the mapping of continuous urban landscape presents some difficulties. What degree of intensity of continuity is necessary, for instance, and how strictly is continuity itself to be interpreted? The chief lines of conurban linkage shown in Fig. 2, which are the result of observation and cartographical experiment carried out by the author during recent years, represent *virtually continuous non-agricultural development of the landscape on at least one side of Class A roads (though including farm-buildings where these form part of a built-up area)*. Short isolated lapses in continuous linkage have been ignored where the lapse did not exceed about 200 yards, and only those Class A roads with important conurban development extending markedly beyond the main settlements have been investigated. The width of the lines is uniform and does not, therefore, show the *depth* of conurban development.

Conurban Linkage

An inspection of Fig. 2 in conjunction with Fig. 1 suggests the extent to which it is possible to speak of a major conurbation based on Derby, Nottingham and the Erewash valley. Nottingham itself is securely linked by continuous urban landscape to two towns on the Derbyshire bank of the Erewash, these being Heanor (*via* Eastwood) and Long Eaton (*via* Beeston). The link with Heanor also continues north-westwards to Ripley, at the head of the small valley of the Bottlebrook, a left-bank tributary of the Derwent. North of Eastwood and Ripley two lines of less continuous conurban development converge on Alfreton. Lying on either side of the road from Nottingham to Ilkeston there is, however, a rural enclave which may be held to qualify serious acceptance of a Nottingham-Erewash conurbation.

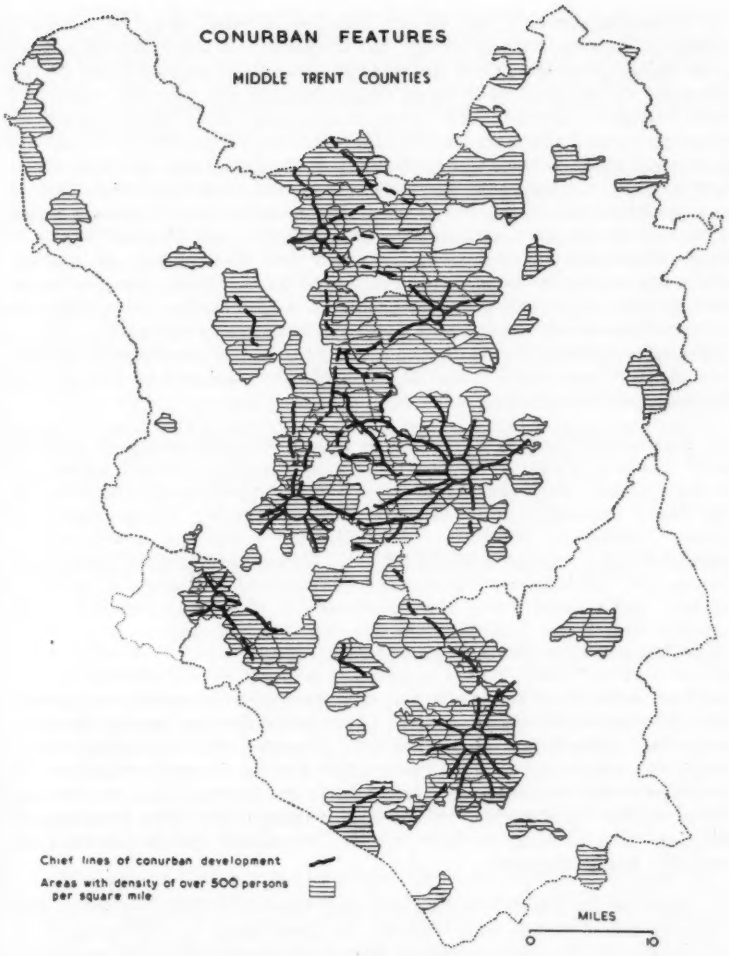

Fig. 2

For key to Urban Centres see Fig 1.

Between Long Eaton and Derby it will be seen that there is only one very short break in conurban linkage, and here residential development may have been discouraged by the low-lying nature of the ground and the proximity of canal and railway. If this break is ignored it is possible to speak of a Derby-Nottingham conurbation based on a sixteen mile axis of road communication following the north bank of the lower Derwent and the Trent. Upstream from Derby there is partial linkage in the Derwent valley as far as Belper, and parallel to this there is a similar sporadic development up the Bottle-brook valley as far as Ripley. Except for the route to Long Eaton, Derby, unlike Nottingham, has no direct links with the Erewash valley and is in fact separated from it by an extensive tract of rural territory containing several parishes with densities of less than 500 persons per square mile.

Nevertheless there is, as we have seen, what may be called a conurban web embracing Derby, Nottingham and the Erewash valley, even though the area does not possess either the compactness or the intensity of urban development characterising the officially accepted conurbations of this country. Despite this there may well be a case for geographers and planners to treat this quasi-conurbation as one entity. It may be said to consist of an equilateral triangle with sides of about fifteen miles in length, the apex being situated in the Alfreton district and the base lying along the Derby-Nottingham axis. Its western side is formed by the parallel valleys of the Derwent and the Bottle-brook, while its eastern side lies along the road from Nottingham to Selston. This may be considered as being reinforced by the Leen valley as far as Nottingham's northern industrial suburb of Hucknall. Internally the conurban triangle, which has a total population exceeding 850,000, is further strengthened by its bisection along the line of the Erewash valley, though important rural enclaves persist to the east and to the west of Ilkeston, particularly in the latter direction.

The satisfactory delimitation of this quasi-conurbation is complicated by the fact that settlements at the head of the Erewash valley are in close contact with the Mansfield urban group, although the latter is effectively separated from Greater Nottingham by thinly-populated Bunter Sandstone country. Intermittent conurban development, associated with mining settlements, also occurs between Mansfield and Chesterfield and between Alfreton and Chesterfield, but is not sufficiently intense, quite apart from the intervention of several parishes with densities below the minimum, to warrant the suggestion of a major conurbation in this northern part of the coalfield.

Just as Greater Mansfield has associations with another industrial area—the Erewash valley—so the Chesterfield-Staveley, or mid-Rother, group has connections with Sheffield. Partial conurban linkage here crosses the watershed of the Don and the Rother, reaching Chesterfield down the valley of the small River Drone on the west and penetrating almost as far as Staveley on the east through the large parishes of Beighton and Eckington into which "overspill" from Sheffield is currently being directed.

South of the Derby-Nottingham axis there is a thinning-out of the populous zone, which may indeed be considered as bifurcating at Loughborough, one arm extending westwards through the Leicestershire coalfield to the Burton-Swadlincote urban group, and the other curving south-westwards through Leicester to Hinckley. This latter belt exhibits marked conurban tendencies only in Greater Leicester, although there is partial linkage along the left bank of the lower Soar between Leicester and Loughborough and also within Hinckley Urban District. Here, it should be noted, conurban development proceeds over the county boundary and extends in almost continuous fashion to Coventry *via* Nuneaton and Bedworth.

Middle Trent and the "Axial Belt"

The population concentrations and conurban tendencies illustrated in these two maps thus direct attention to one major though as yet incomplete conurbation based on Derby, Nottingham and the Erewash

valley(1), with a total population not far short of one million, and to three minor conurbations with populations in the region of 100,000-130,000, based respectively on Burton-on-Trent—Swadlincote, Chesterfield—Staveley, and Mansfield with Kirkby and Sutton-in-Ashfield. In addition to these is Greater Leicester, a compact urbanised area with a population of about one-third of a million.

Finally it should be pointed out that the central populous zones within which these lie form part of a wider concentration of population involving the major industrialised areas of the Midlands, south Lancashire and West Riding. Together these areas form the northern half of the so-called "axial belt", or "hour-glass" as it has rather more appropriately been called(2). This northern component may, however, also be likened to an arc or crescent of varying width and population density which extends in a broad sweep from the Mersey to the Severn, and which incorporates nine cities of over a quarter of a million inhabitants—Liverpool, Manchester, Bradford, Leeds, Sheffield, Nottingham, Leicester, Coventry and Birmingham—with Stoke-on-Trent appearing as an outpost within the curve of this figure. It is to this crescent that the central populous zones of the Middle Trent counties may, from the wider view, be considered to belong.

BLAST FURNACE CENTRES IN BRITAIN

E. M. RAWSTRON

Statistics for the iron industry, though plentiful, are not published in a form amenable to detailed mapping plant by plant. Indeed the pig-iron output of areas as large even as the East Midlands and Lancashire (including Flint and Cheshire) cannot be distinguished separately from Essex and south Yorkshire respectively. To attempt to assess the relative importance in Britain of the East Midlands as an iron producing region is therefore beset with difficulty and neither the output nor capacity of individual plants within the area can be mapped from available published data.

In view of this it has been considered worthwhile to construct a map based on the hearth area of blast furnace plants in 1953. These statistics, which are published(3), provide perhaps the best available guide to approximate capacity and output. The circles on the map overleaf are therefore proportional to the hearth area at each plant in Britain except that the concentrations of plants at Middlesbrough, Scunthorpe and near Chesterfield(4) have in each case been totalled to form one circle.

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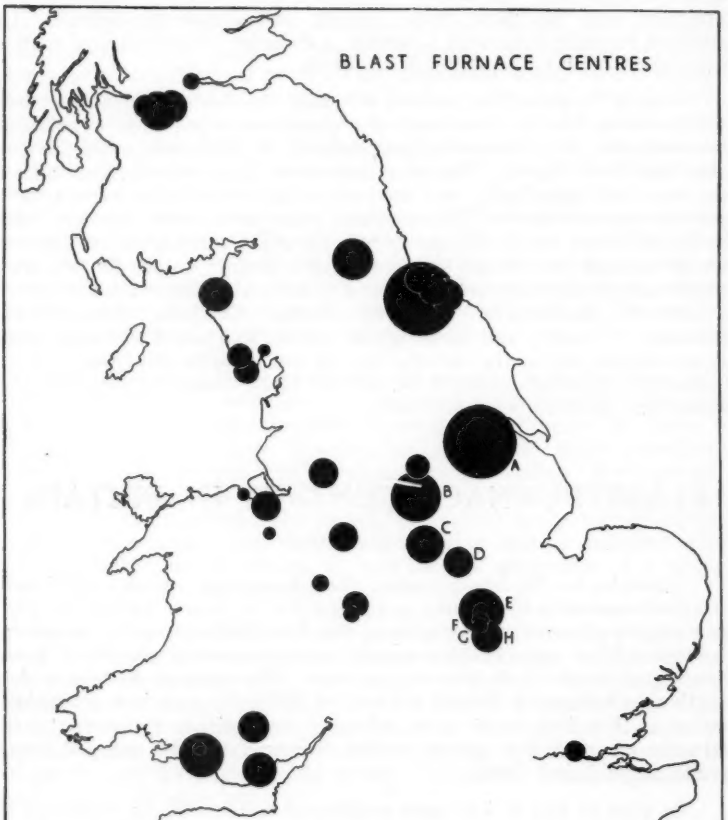
(1) Although post-war planning policy is tending to prevent further spontaneous consolidation, since the Derbyshire County Plan deprecates further development along the Derby-Nottingham axis, it does, however, make provision for considerable expansion at Alfreton, thus lending weight to its selection as the northern terminus of our conurbation.

(2) See J. N. L. Baker and E. W. Gilbert, *op. cit.*, A. E. Smailes, "The Urban Hierarchy in England and Wales", *Geography*, XXIX, 1944, and *idem*, "The Urban Mesh in England and Wales", *Transactions and Papers, Institute of British Geographers*, 1946.

(3) British Iron and Steel Federation, *Statistical Year Book for* 1953, Table 22.

(4) Clay Cross, Renishaw, Sheepbridge and Staveley.



Circles are proportional to the hearth area available for simultaneous use at each plant or group of plants.

A—Scunthorpe ; B—Chesterfield area ; C—Stanton ; D—Holwell ; E—Corby ; F—Kettering ; G—New Cransley ; H—Wellingborough.

Although it is impossible to determine the hearth radius to within one foot and the hearth area so calculated takes no account of the height of the furnace, it is felt that the map is a reasonable presentation of the relative importance of individual plants as pig-iron producers. The table below gives some indication of the accuracy of the hearth area as a guide to output.

Iron and Steel Federation Standard Areas	Percentage output 1953	Percentage hearth area 1953
Lincolnshire	14·00	15·4
North-East Coast	23·75	25·3
East Midlands (including Dagenham) ..	20·25	21·8
South Wales	14·80	11·5
North-West Coast	8·30	6·3
West Midlands	4·25	5·0
Lancashire, etc. (including Park Gate, Rotherham)	7·00	6·5
Scotland	7·75	8·2

Within the East Midlands blast furnace plants are concentrated in three localities. The largest and most compact group is at Scunthorpe in north Lincolnshire on the Lower Lias orefield. It comprises three plants. The second group consists of the plants at Corby, Wellingborough, Kettering and New Cransley (near Kettering); these are related to the ore production of the Northants Sands. The third concentration is located in the Chesterfield district where coking coal is available—as it is also in south Yorkshire where there is only one plant, that at Park Gate near Rotherham. Sheffield, it should be remembered, has no blast furnaces. The coal-measure ores of south Yorkshire and the Chesterfield district though not exhausted are no longer economical to work. There are two other plants in the East Midlands, Stanton at the southern end of the Yorks., Derby and Notts. coalfield and Holwell (near Melton Mowbray). The former is today neither very near coking coal nor iron ore but the latter is situated on the Middle Lias Marlstone from which almost self-fluxing ore is obtained.

An important point to notice is that the blast furnace units in the East Midlands, with the exception of Scunthorpe, lie along the former Midland railway route from London through Kettering, Nottingham and Chesterfield to the north. This provides an axis along which the interchange of coal, coke and iron ore can be effected. It is in fact the major industrial axis of the region upon which many centres of engineering, both heavy and light, rely for their basic materials.

EAST MIDLAND RECORD

The Peak District National Park

The designation of 542 square miles of the Southern Pennines in 1950, as the Peak District National Park brought into being the first of a series of twelve Parks planned for England and Wales. The boundary which defines what is essentially an upland area has for the sake of administrative convenience been made coincident with local authority boundaries. The headquarters of the Joint Planning Board has been established at Bakewell. The natural scenery of this region and its position in relation to densely populated urban areas have long combined to make it a recreational area of considerable importance, clearly qualifying it to become a National Park. The threat to the visual amenities of the district from economic exploitation of the land brought added urgency to the need for Park status.

Map showing boundary of Peak District National Park.
Dotted area indicates land over 1,000 feet above sea level.

The main attraction of the Peak is the contrasted scenery of its three main types of country. The domal uplift which affected the greater part of the district involved limestone and grit-shale rocks which have responded diversely to subsequent denudation. The central part of the Park is an area (145 square miles) of upland limestone country with well over half its surface above 1,000 feet O.D., and reaching heights of over 1,300 feet in the west and north. The undulating plateau of this inner district is dissected by a series of dales, deep and well-wooded, with cliff and scree development in the lower stretches and trailing off upstream into cultivated shallow dry valleys.

Almost the entire limestone country is enclosed and cultivation extends to the highest summits. About 91% of the district is farmland (L.U.S. Survey 1931-35), the remaining area of rough grazing being evenly divided in distribution between the higher ridges, with a thin peat covering, and the narrow rocky dales. As a result of the comparatively unattractive nature of the upper plateaux, tourist activity is concentrated in the dale and dale-fringe areas which provide the best walking country. The subterranean phenomena which are well-developed on the periphery of the limestone district also attract visitors, and are exploited commercially at Castleton, Matlock and Buxton.

Bordering the limestone uplands and in places separating them from the grit country, are broad vales formed on the weaker Edale Shales. The cultivated lowland aspect of these valleys contrasts with the wilder scenery of the nearby uplands, while they contain centres convenient for the exploration of all three types of country.

The outermost tract of country is the tabular gritstone upland, which everywhere has a bold relief. This reaches its maximum height in the Kinder Scout-Bleaklow area where the highest plateaux are a little over 2,000 feet. The East Moor comprises a gently eastward dip-slope bordered on the west by a persistent cliff "edge". In the western section of the Park are a series of broken parallel ridges reaching their highest point around Axe Edge (1,810 ft.). The semi-natural vegetation associations of these high moorlands exhibit close relationship with soil and drainage conditions, the main contrast being between the cotton grass "mosses" of the flat upper tableland surfaces and the heather, bracken and bilberry patches of the slopes. Some 216 square miles or 55% of the gritstone and shale country is uncultivated, and the bulk unenclosed, making this one of the most expansive tracts of open land in the country.

Judged solely from the viewpoint of its location in relation to the distribution of urban population the Peak is an obvious choice for a National Park. Within ten miles of the boundary are the south Lancashire and North Staffordshire conurbations, Sheffield, Huddersfield and Oldham. Altogether there are thirteen urban centres with a population of over 100,000 each within twenty-five miles of the boundary, while it is estimated that half the population of England live within a 60 mile radius of Buxton. The close proximity of this densely populated area coupled with ease of access has naturally tended to make the day tripper the characteristic visitor to the District. The bulk of visitors are of relatively local origin ; statistics of the Y.H.A. show that three-quarters of the visits to Youth Hostels in the district are made by hostellers originating from the Midlands, West Riding and Manchester regions.

While eminently suitable as a recreational area the Park contains several activities which restrict or spoil its use for this purpose. The visual amenities have been much affected by the economic exploitation of minerals, the construction of large water-supply reservoirs, re-afforestation of upland valleys and incongruous building development. The purchase or lease of large areas of moorland within the district either for water catchment or grouse shooting and the application of a policy designed to protect a single type of land-use, severely restrict public enjoyment of the open country.

Although fluorspar and barytes, silica sand, fireclay and gritstone are all quarried in the Peak, the development of the large-scale quarrying

of limestone and igneous rocks presents the major control problem for the Planning Authority. In 1950 the Peak limestone area produced 5½ million tons of limestone equal to 22% of the production of the United Kingdom. Of this amount the National Park itself produced 701,000 tons or 2·8% of the national total. A 35 square miles area of limestone country containing the major quarry concentrations has been omitted from the National Park, so excluding a landscape made intractable by quarrying operations and at the same time providing for the future extension of the industry. The narrow 9 mile long enclave south of Chapel-en-le-Frith and the bulge of the Park boundary north of Wirksworth are due largely to this provision.

The problems posed by reservoir construction and restrictions on the utilisation of their gathering grounds are peculiar to the shale and gritstone area. Some 166 square miles of the National Park or 31% of its area (44% of the grit-shale area) are gathering grounds for supply reservoirs. The greater part of these same moorlands, as well as several lying outside the gathering grounds, are preserved for grouse shooting. The prevention of access by the sporting and water catchment interests and the absence of an adequate system of public footpaths has effectively deprived the public of a large proportion of the most attractive walking country. Before the first access agreement in 1953 the public had a right of way in the Park to only two of the twenty summits over 1,750 feet.

Major deviations from the traditional building materials and designs in use in the District during the period preceding the application of planning control, have done much to damage the appearance of many villages. This is particularly the case with settlements of the Hope and Derwent valleys, whose recent growth has resulted from the development of a dormitory function.

A brief mention of some of the competing forms of land use within the Park boundary indicates the size of the problem facing the Joint Planning Authority. In this National Park above all others, claims for the economic exploitation of the land strongly challenge the more abstract and essentially social claims for recreational use.

To meet this challenge the Planning Authority have statutory powers not only to preserve the natural beauty of the Park landscape by the control of development, but also to enhance it by landscape treatment, and to improve the recreational facilities by the arrangement of public access and additional accommodation.

This new phase in the development of the Peak District cannot fail to be of interest to the geographer, for the concentration of almost the whole range of National Park problems within this single example offers in their solution the possibility of a considerably changed landscape and the emergence of a clearly defined region of recreation.

J.G.M.

Lead Mining in Derbyshire

Lead mining from vertical or near-vertical veins or "rakes" in the massive limestone of Derbyshire dates back to Roman or even pre-Roman times. Several pigs of lead bearing the superscription of the Legions of Rome have come to light along moorland tracks in the County, though lead production in modern times has been relatively small and today it is doubtful whether home production of this metal exceeds 1% of our consumption.

Mineral rights in what was a Royal Hunting Field are vested in the Crown and the finder of a lead vein can apply to the Barmote Court at Wirksworth for a title to sufficient land and water to enable the lead ore (galena) to be worked irrespective of the ownership of the land. The presentation of a dish of ore to the Barmaster frees the mine and thereafter every 13th dish is payable to the Lord of the Field as royalty. The application of a knowledge of "ancient rights" in the Wapentake at Wirksworth recently yielded a bonus to a quarryman who spotted a lead vein and staked his claim on a freshly exposed limestone face in a Wirksworth quarry. The quarry owners had to part with some hundreds of pounds to regain the title of the land traversed by the vein for the Law of Barmote Court still holds good. The spar minerals occurring in the vein along with the ore remain the property of the landowner, who may at his own expense extract them from spoil heaps. The fact that such gangue minerals as fluorspar, barytes and calcite had in the past little or no value resulted in the formation of extensive hummocky tips which together with abandoned mine shafts mark the sites of old lead workings, particularly in the eastern sector of the Derbyshire Dome. The area was approaching exhaustion by the middle of last century and with one exception, the Millclose mine, all workings have been relatively small. The Millclose mine, Darley Dale, after being abandoned for 100 years was worked from 1861 until its closure in 1944. Similar geological conditions to those existing at Millclose are known to exist in other parts of the County and new deposits of lead and zinc ores may well be discovered. Generally speaking the exploration would be costly and speculative and would have to be on a large scale and backed by ample resources. Such an exploratory drift has recently been granted planning consent in the Liberty of Matlock. The soughs or tunnels constructed to drain the mines and to prospect for new veins during the past century were driven without profit, though the water—thermal in places—which pours from these channels, makes a valuable contribution to the water supply of the county.

Except for occasional sporadic workings no large lead mining unit is now operating in Derbyshire. A small quantity of ore is recovered incidentally to the working and recovery of spar minerals from underground and surface diggings. Such minerals which were thrown back with the spoil material into worked-out mines or were dumped on the surface are today of high value and, despite some objection on amenity grounds to re-working these localities, the recovery of fluorspar and barytes in the interests of dollar-saving has official blessing. The making of zebra crossings and white road lines has even stimulated the production of the less valuable calcspar or calcite from which any lead ore is removed as an impurity. Thus the waste of yesterday has become the marginal reserve of today and may well provide the main product of tomorrow.

Whereas with the help of Millclose mine this country produced over 50,000 tons of lead in 1934, the present annual production is of the order of 3,000 tons, mainly from the North Pennine ore-field. Australia and Canada are able to supply our requirements but as the price of this base metal rises modern industry turns increasingly to the use of substitute metals. A further sharp rise in price might stimulate the search for hidden reserves of lead ore in Derbyshire but after two thousand years of exploitation little ore probably exists above the water table and it is uncertain whether galena does not in fact give way in depth to either blende or zinc ore.

S.G.C.

A Lincoln Industrial Centenary

The year 1954 marks the centenary of the foundation of Messrs. Robey & Co., the well known Lincoln engineering firm. In 1854 John Robey who was apprenticed in Lincoln, set up a small works for the manufacture of steam engines, boilers and threshing machines and later the same year exhibited a portable steam engine at the RoyalAgricultural Show which was held on a site now occupied by the present extensive works of the firm. Robey's however was not the first enterprise of its kind in Lincoln and the real significance of the centenary is that it commemorates the important developments throughout the "fifties" which radically changed the character of Lincoln as a town. For it was mainly during that decade that the latter became an industrial centre.

In the "forties" Clayton and Shuttleworth (now Smith-Clayton) began making steam engines and eventually threshing machines. They were followed in 1849 by Gwynnes, producing pumps and pumping machinery—an industry reflecting the problems of land drainage in the Fens and other parts of Lincolnshire. John Cooke founded the Lindum Plough Works in 1851 ; Forsters, originally concerned with flourmilling, began making threshing machines in 1856 and Rustons, whose forms of agricultural machinery at first closely resembled Robey's, started production in 1857. Local initiative in engineering development benefited from the railway connections by which coal and iron could be brought to the town. The Midland line from Derby and Nottingham reached Lincoln in 1846 and the Great Northern line from Peterborough in 1848. As the reputation of the products grew, an expanding market was found extending beyond the immediate agricultural area to the country at large and thence abroad. Several of these Lincoln firms in fact established branches at places in the great grain-producing areas of central and eastern Europe, at Prague, Vienna, Buda-Pest, Breslau, Cracow, Czernowitz (Cernauti), Galatz and Odessa. Later on, with the development of mass-manufactured agricultural machinery in U.S.A. and Canada and other changes taking place, the Lincoln engineering firms, continuing as pioneers in new forms of production, became more specialized and eventually agricultural equipment became relatively less important in the widening range of output. Robeys for example now concentrate largely upon electric winding-gear for mining operations and other specialized forms of machinery, though like most of the neighbouring concerns production is not tied rigidly to a particular group of goods.

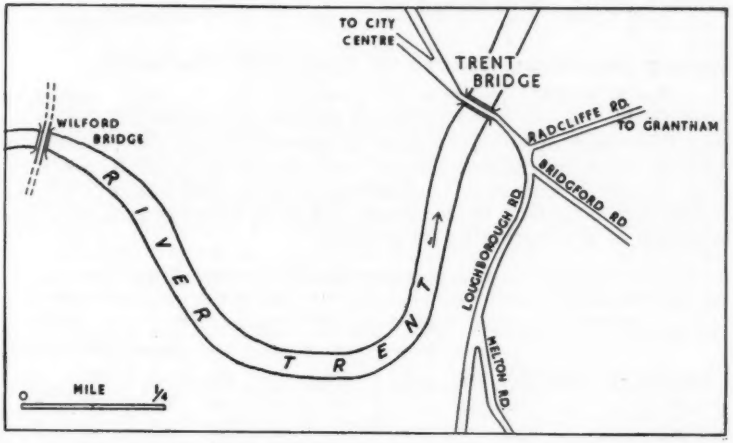
Thus in the "fifties" the ancient city entered a new phase in its development, that of an industrial centre dominated by engineering trades and this in the main is its economic rôle today. Geographically this phase is reflected in the spread of the town along the Witham and southwards from the cathedral heights. In terms of population, it is reflected in a rapid growth from only 17,500 in 1851, to 50,000 at the turn of the century and 70,000 today. What occurred in Lincoln also took place in many other leading market towns of eastern England but no better example can be found with which to illustrate the process by which such centres were functionally transformed.

K.C.E.

A Traffic Census at Trent Bridge

Since there is only one major road-crossing over the Trent at Nottingham great interest attaches to the growth of traffic and the urgent demand for another bridge. (Besides Trent Bridge there is a smaller

bridge at Wilford a short distance upstream but since tolls are levied and it does not directly serve main roads, it carries relatively little traffic.) Thus a great volume of traffic entering Nottingham from the south and east, and in the reverse direction, is concentrated upon the one crossing resulting in intense congestion especially at peak periods.



The situation which grows steadily worse has been under observation for a number of years, traffic censuses having been taken by members of the Department of Geography in 1939, 1949, 1950 and 1954. The results of the last census which was taken on Tuesday, the 12th October, over a period of sixteen hours from 6 a.m. to 10 p.m., are summarised in the table below but a more detailed account of the growth and changing nature of the traffic will be published in a future issue.

Type of Vehicle.	Radcliffe Road		Loughborough Road		Bridgford Road		Total	Total
	IN	OUT	IN	OUT	IN	OUT	IN	OUT
Private Cars	2,502	2,632	4,085	3,810	1,714	1,526	8,301	7,968
Light Lorries and Vans ..	1,424	1,441	2,090	1,894	448	472	3,962	3,807
Heavy Lorries	338	375	555	657	31	22	924	1,054
Buses..	329	329	447	445	225	239	1,001	1,013
Motor Cycles	276	298	483	441	237	213	996	952
Total ..	4,869	5,075	7,660	7,247	2,655	2,472	15,184	14,794
Grand Total	9,945		14,907		5,127		29,979	

The figures show that almost half the traffic 14,907 vehicles out of a total of 29,979, moved along Loughborough Road, the principal route via Loughborough (or Melton Mowbray) to Leicester and the south, thus clearly demonstarting the need for the projected new bridge upstream from the present one. Mention should also be made of the traffic census taken by the Ministry of Transport over the same period each day from the 16th to the 22nd August, 1954. During that week an average of 33 vehicles an hour passed over Trent Bridge ; on the 12th October the average was 31. The official census revealed that at the 14 check points in Nottingham, 85% more goods vehicles were recorded than in

1938 and 39% more private cars. The comparable figures for the unofficial censuses of 1939 and 1954 at Trent Bridge were 84% and 4%. Thus while the censuses are in close agreement as to the increase of goods vehicles, they differ strikingly as to private cars, but a further analysis of the detailed statistics will be necessary before this discrepancy can be satisfactorily explained.

D.R.M.

Recent Industrial Growth in Towcester, Northants.

The economic character of Towcester has recently undergone considerable change. The people of this small country town were for long dependent upon employment in agriculture and the provision of services for an agricultural district. Industry played a small part in the local economy and such manufacturing as existed before 1939 was closely associated with the local area, originally either as a source of raw materials or as a market for its products.

Table I.—Number of Employed Persons

Group.	1939		1947		1950		1953	
	Male	Female	Male	Female	Male	Female	Male	Female
Agriculture (incl. horticulture)	637	5	674	42	762	54	687	39
Engineering	164	5	153	16	144	6	404	162
Clothing	6	7	8	13	53	353	50	246
Total manufactures	336	39	427	67	509	399	814	488

Table I shows certain details of the changing employment structure of Towcester and the surrounding rural area. Two features are clearly apparent : (i) agriculture has remained relatively stable as a source of employment throughout the period and (ii) manufacturing industry (mostly light) has greatly expanded. Within the latter engineering shows a large increase while clothing, virtually unrepresented before the war, accounted in 1953 for nearly 25% of the total employed in manufacturing. Most of the expansion in engineering is due to the activities of one firm with its parent plant located at Ilford which has established four branches in the Towcester district. Footwear, an off-shoot of the Northampton industry, is responsible for all the increase in clothing.

It is clear that the post-war development of industry is largely dependent on the introduction of plant from outside rather than upon the growth of concerns based on local raw materials and markets. The reasons for this movement are not hard to find. Untapped labour supplies, space and cheap land for expansion are the chief attractions for the industrialist in the Towcester area since the mobility of industry has been increased by the general availability of efficient road transport and electrical power. In this connection the excellent road communications of Towcester in relation to industrial areas, especially such centres as London, Birmingham and Northampton, are a significant factor in its favour.

All these conditions were operative as long ago as the 1930's. The only important changes enhancing Towcester's attractiveness to industry since then have been the coming of full employment, stricter control over industrial location, the housing shortage, and the development of new firms making "light" products. Of these changes the first is the most important.

TABLE II.—UNEMPLOYED PERSONS AS A PERCENTAGE OF INSURED POPULATION

	1947	1948
Towcester	0·2	0·3
National Average	1·5	1·4

Yet it appears from Table II that available labour in Towcester at the beginning of the post-war industrial expansion was proportionately less than in the country as a whole. Nor has the population of Towcester and district increased sufficiently since 1947 to supply all the new demands for labour in manufacturing industry. It would seem that a considerable proportion of the new labour supply comprises women (many of them married) for whom little regular employment was formerly available within convenient travelling distance. Towcester now functions as a focus for this type of labour both from the town itself and from an increasing area surrounding it. Evidence in support of this view is given below in Table III.

TABLE III.—PERCENTAGE INSURED FEMALES OF TOTAL INSURED

	1929	1939	1947	(1) 1948A	(2) 1948B	(3) 1953
Towcester	5·5	7·7	14·7	21·2	28·7	31·2
National Average ..	28·0	29·0	30·1	29·7	33·2	—

(1) Until 1948 old boundaries and methods of computation.
(2) New boundaries and methods of computation.
(3) Estimated.

Although Towcester still has a lower percentage of female employment than the country as a whole, it is now greater than many other country towns. This may indicate that an upper limit to industrial development is very nearly reached at Towcester. Already one footwear firm has experienced difficulty in obtaining sufficient labour. While it is recognised that other country towns are following a parallel course of industrial development, a precise description of the process over a larger area requires further investigation.

I.G.W.

TIDAL FLOODING ON THE LOWER TRENT

An unexpectedly high tide occurring in the early hours of October 14th caused flooding at Hull and other places along the Humber and the lower Trent. This tide as predicted would have been high since it was an equinoctial spring tide but the level of high water reached considerably exceeded the estimated figure. In fact it was the highest tide since that accompanying the storm surge of January 31st, 1953 and on the Trent it was the highest since 1921. The first warning was received from the harbourmaster at Grimsby about 5.45 a.m. but by 7 a.m. the river was already in flood. At many places below Owston Ferry the banks were overtopped and at two points, one just below Keadby and the other at Island House near the mouth, the banks were breached. Several hundred

acres of land were temporarily flooded, including some 50 acres under sugar beet north of Keadby, but shortly before the evening tide, which was three feet lower than the previous, the breaches were sealed. In the Gainsborough neighbourhood the new flood wall, constructed after the disaster of 1947, held firmly and the town was not endangered.

It is possible that local meteorological conditions may have been primarily responsible for this abnormal tide since it appears that other parts of the East Coast were unaffected. At 6.0 a.m. a cold front passed over the Humber area moving south-eastwards (see Daily Weather Report No. 33929 issued on October 14th, 1954). On the south side of the front fresh to strong S.W. winds had been blowing for some hours and may have caused a lowering of sea-level in the area. On the north side winds were slack. The passage of the front may then have led to a movement of water towards the coast coinciding with the time of the high spring tide. In these circumstances no abnormal high water would be expected either to the north or south of the Humber area.

A month later, on November 12th which was also a period of high spring tides, flooding recurred in the Humber and lower Trent. Hull again suffered, the river banks were overtopped at Keadby causing a temporary inundation of part of the Grimsby-Doncaster road (A18) and several breaches were made along the lower reaches. On this occasion the tide in the Trent was the highest since 1930 when modern records began, and possibly since 1921. The exceptional level this time was caused by the combination of an unusually high tide with an abnormal volume of fresh water in the river following prolonged rains.

K.C.E.

FIRST DEGREE DISSERTATIONS

Prepared in the Department of Geography

In the University, Geography may be read as a subject in the Faculty of Arts, under the Board of Studies in Law and Social Science (Faculty of Arts) and in the Faculty of Pure Science. Since the award of the Charter to the University in 1948 all students taking an Honours degree in Geography have been required to submit a dissertation as part of their final examination. Only those dissertations relating to East Midland subjects are listed below. *Bona fide* students or research workers may be permitted to consult them on application to the Department. Titles of higher degree theses and first degree dissertations presented in 1950, 1951, 1952 and 1953 were published in the June issue.

1954

Lincolnshire : the Ancholme Levels north of Brigg. Drainage and land use. A. Straw.

An account of coal mining in the Dukeries and associated population trends. G. D. Kerr.

Retford. Its form and function. M. Wilson.

The parish of Widmerpool, Notts. A comparative study in agriculture and settlement. Shirley G. Youngman.

Some aspects of the recent industrial growth of English country towns with specific reference to Towcester, Oakham and Stowmarket. I. G. Weekley.